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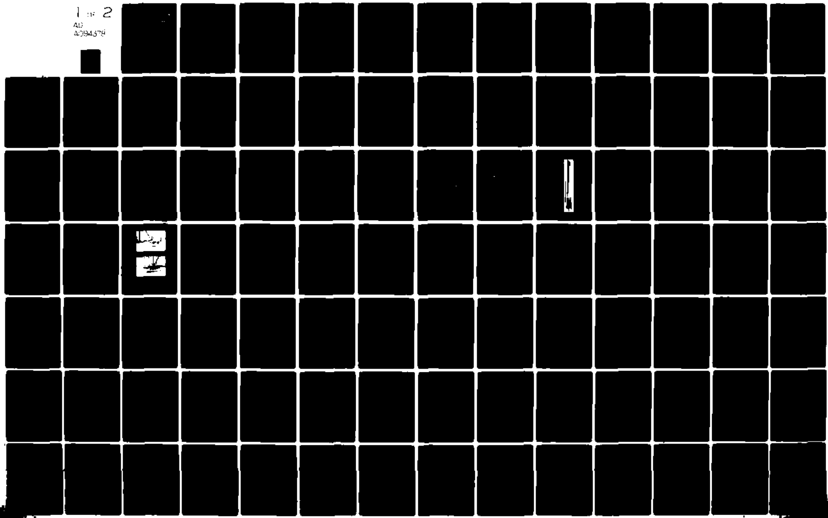

PROPELLER-DISK WAKE SURVEY DATA FOR MODEL 4989 REPRESENTING THE FF 1052-CLASS SHIP IN A TURN AND WITH A BASS DYNAMOMETER BOAT

DTNSRDC/SPD-0011-21

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DAVID W. TAYLOR NAVAL SHIP RESEARCH AND DEVELOPMENT CENTER

Bethesda, Maryland 20084

PROPELLER-DISK WAKE SURVEY DATA FOR MODEL 4989 REPRESENTING THE FF 1052-CLASS SHIP IN A TURN AND WITH A BASS DYNAMOMETER BOAT

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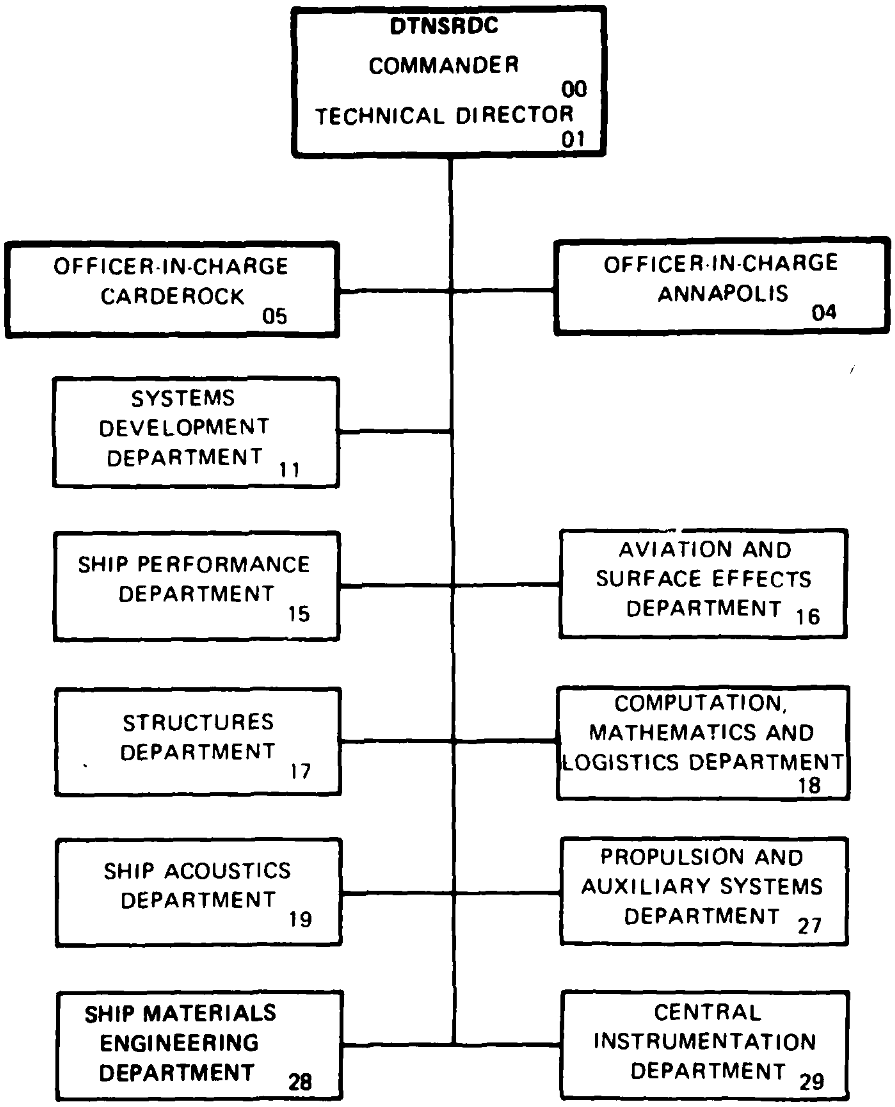

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Experiments are described in which the wake in way of the propeller disk was determined for several conditions on a model of the FF 1052 Class ship in connection with an investigation to determine blade loadings on a controllable pitch propeller. The wake surveys were conducted with and without a dynamometer boat behind the hull model to determine the effects of the presence of the dynamometer boat on the flow through the propeller disk of the model. Next, wake data were obtained for the model in several conditions while turning in the Rotating Arm Facility. Finally, the model was towed in a straight line

20. with a yaw angle corresponding to that used in the turning experiments to assess the differences in results for these two techniques.

The results show that the major change in the experiments with and without the dynamometer boat is that the longitudinal velocity component ratio (V_x/V) with the boat is about 12 percent lower than without throughout the circumference of the propeller disk. The higher harmonics (7-10) of the circumferential distribution of both the longitudinal and tangential velocity component ratios are greater for the experiments with the dynamometer boat. As anticipated, there are major changes in the tangential and radial velocity component ratios in turns as compared to straight and ahead operation. The longitudinal component is also affected to some degree. The results of the yawed experiments are not in good agreement with those from the turning experiments.

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NOTATION

CONVENTIONAL SYMBOL	SYMBOL APPEARING ON PLOTS	DEFINITION
A_N	COS COEF	The cosine coefficient of the $N^{\underline{th}}$ harmonic*
B_N	SIN COEF	The sine coefficient of the $N^{\underline{th}}$ harmonic*
C	C	Pressure reading at center hole of 5-hole pitot tube
D	---	Propeller diameter
J_V	J_V	Apparent advance coefficient $J_V = \frac{V}{nD}$ (dimensionless)
N	N	Harmonic number
n	---	Propeller revolutions
P	P	Pressure
r/R or x	Radius or RAD.	Distance (r) from the propeller axis expressed as a ratio of the propeller radius (R)
R_n	R_n	Reynolds number
R1, R2	R1, R2	Pressure reading at radial holes of 5-hole pitot tube
T1, T2	T1, T2	Pressure reading at tangential holes of 5-hole pitot tube
U/U_∞	U/U_∞	Non-dimensional longitudinal velocity measured by means of boundary layer pitot tubes
V	V	Actual model or ship velocity
$V_b(x,\theta)$	---	Resultant inflow velocity to blade for a given point
$\bar{V}_b(x)$	---	Mean resultant inflow velocity to blade for a given radius
$V_r(x,\theta)$	VR	Radial component of the fluid velocity for a given point (positive toward the shaft centerline)

(*see footnote on page xv)

NOTATION (CONTINUED)

CONVENTIONAL SYMBOL	SYMBOL APPEARING ON PLOTS	DEFINITION
$\bar{V}_r(x)$	---	Mean radial velocity component for a given radius
$V_r(x,\theta)/V$	VR/V	Radial velocity component ratio for a given point
$\bar{V}_r(x)/V$	VRBAR	Mean radial velocity component ratio for a given radius
$V_t(x,\theta)$	VT	Tangential component of the fluid velocity for a given point (positive in a counterclockwise direction looking forward)
$\bar{V}_t(x)$	---	Mean tangential velocity component for a given radius
$V_t(x,\theta)/V$	VT/V	Tangential velocity component ratio for a given point
$\bar{V}_t(x)/V$	VTBAR	Mean tangential velocity component ratio for a given radius
$(\tilde{V}_t(x)/V)_N$	AMPLITUDE	Amplitude (B_N for single screw symmetric; C_N otherwise) of Nth harmonic of the tangential velocity component ratio for a given radius*
$V_x(x,\theta)$	VX	Longitudinal (normal to the plane of survey) component of the fluid velocity for a given point (positive in the astern direction)
$\bar{V}_x(x)$	---	Mean longitudinal velocity component for a given radius
$V_x(x,\theta)/V$	VX/V	Longitudinal velocity component ratio for a given point
$V_x(x)/V$	VXBAR	Mean longitudinal velocity component ratio for a given radius
$(\tilde{V}_x(x)/V)_N$	AMPLITUDE	Amplitude (A_N for single screw symmetric; C_N otherwise) of Nth harmonic of the longitudinal velocity component ratio for a given radius*

NOTATION (CONTINUED)

CONVENTIONAL SYMBOL	SYMBOL APPEARING ON PLOTS	DEFINITION
x/L_{WL}	x/L_WL	Non-dimensional longitudinal location of boundary layer pitot tubes
ϕ_N	PHASE ANGLE	Phase angle of Nth harmonic*

*The harmonic amplitudes of any circumferential velocity distribution $f(\theta)$ are the coefficients of the Fourier Series:

$$f(\theta) = A_o + \sum_{N=1}^{N} A_N \cos(N\theta) + \sum_{N=1}^{N} B_N \sin(N\theta)$$
$$= A_o + \sum_{N=1}^{N} C_N \sin(N\theta + \phi_N)$$

NOTATION (CONTINUED)

CONVENTIONAL SYMBOL	SYMBOL APPEARING ON PLOTS	DEFINITION
$1-w(x)$	1-WX	Volumetric mean velocity ratio from the hub to a given radius

$$1-w(r/R) = \left[\frac{2 \cdot \int_{r_{hub}/R}^{r/R} (\bar{V}_{x_c}(x)/V) \cdot x \cdot dx}{(r/R)^2 - (r_{hub}/R)^2} \right]$$

where $\bar{V}_{x_c}(x)/V = \int_0^{2\pi} \left[\frac{V_{x_c}(x,\theta)}{2\pi V} \right] d\theta$

and $V_{x_c}(x,\theta)/V = (V_x(x,\theta)/V) - (V_t(x,\theta)/V) \tan(\beta(x,\theta))$

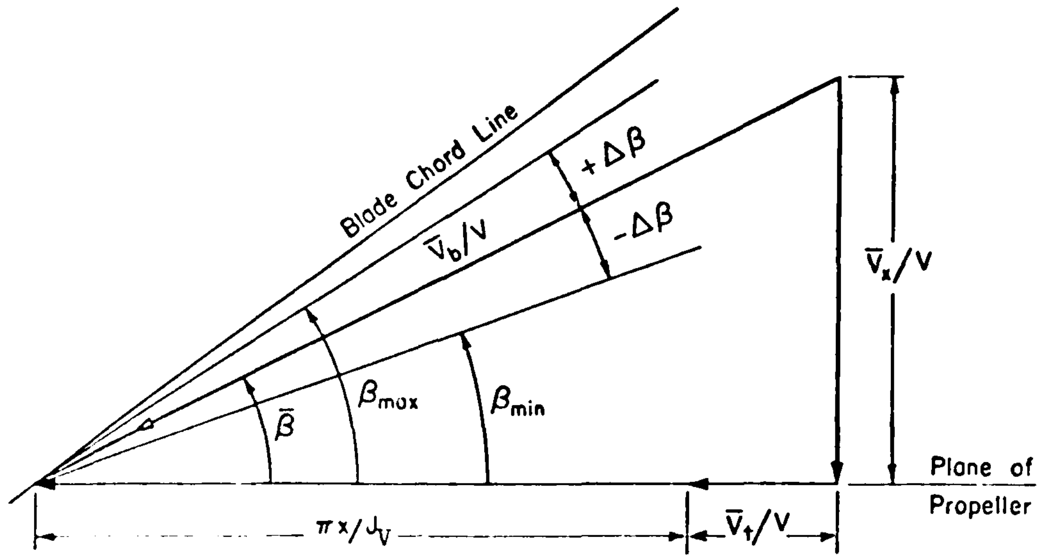
CONVENTIONAL SYMBOL	SYMBOL APPEARING ON PLOTS	DEFINITION
$1-w_v(x)$	1-WVX	Volumetric mean velocity ratio from the hub to a given radius (without the tangential velocity correction)

$$1-w(r/R) = \left[\frac{2 \cdot \int_{r_{hub}/R}^{r/R} (\bar{V}_x(x)/V) \cdot x \cdot dx}{(r/R)^2 - (r_{hub}/R)^2} \right]$$

CONVENTIONAL SYMBOL	SYMBOL APPEARING ON PLOTS	DEFINITION
$\beta(x,\theta)$	---	Advance angle in degrees for a given point
$\bar{\beta}(x)$	BBAR	Mean advance angle in degrees for a given radius
$+\Delta\beta$	BPOS	Variation of the maximum advance angle from the mean for a given radius

NOTATION (CONTINUED)

$-\Delta\beta$	BNEG	Variation of the minimum advance angle from the mean for a given radius
θ	Angle in degrees	Position angle (angular coordinate) in degrees



VELOCITY DIAGRAM OF BETA ANGLES

ENGLISH/SI EQUIVALENTS

ENGLISH	SI
1 inch	25.400 millimetres [0.0254 m (metres]
1 foot	0.3048 m (metres)
1 foot per second	0.3048 m/sec (metres per second)
1 knot	0.5144 m/sec (metres per second)
1 degree (angle)	0.01745 rad (radians)
1 inch Water (60°F)	248.8 pa (pascals)

ABSTRACT

Experiments are described in which the wake in way of the propeller disk was determined for several conditions on a model of the FF 1052 Class ship in connection with an investigation to determine blade loadings on a controllable pitch propeller. The wake surveys were conducted with and without a dynamometer boat behind the hull model to determine the effects of the presence of the dynamometer boat on the flow through the propeller disk of the model. Next, wake data were obtained for the model in several conditions while turning in the Rotating Arm Facility. Finally, the model was towed in a straight line with a yaw angle corresponding to that used in the turning experiments to assess the differences in results for these two techniques.

The results show that the major change in the experimets with and without the dynamometer boat is that the longitudinal velocity component ratio ($\bar{V}_x/V$) with the boat is about 12 percent lower than without throughout the circumference of the propeller disk. The higher harmonics (7-10) of the circumferential distribution of both the longitudinal and tangential velocity component ratios are greater for the experiments with the dynamometer boat. As anticipated, there are major changes in the tangential and radial velocity component ratios in turns as compared to straight and ahead operation. The longitudinal component is also affected to some degree. The results of the yawed experiments are not in good agreement with those from the turning experiments.

ADMINISTRATIVE INFORMATION

The work reported herein was funded by the Naval Sea Systems Command (NAVSEA 05R) Task Area SSL 24001, Task 19977. The work was performed by the David W. Taylor Naval Ship R&D Center (DTNSRDC), Work Units 1-1524-567 and 1-1544-296.

The International System (SI) of units is used in addition to the equivalent English Units in this report.

INTRODUCTION

There has been a major trend in recent designs of combatant ships for the U.S. Navy to use marine gas turbines as prime movers for the main propulsion system. Currently there is no marine reverse gear available within the powering, space and other constraints imposed by this type

of design. The solution to the reversing problem for unidirectional propulsion machinery for a number of years has been the use of the controllable pitch (CP) propeller. The U.S. Navy has had experience in the past in the design of CP propellers for comparatively low powered ships. Structural problems were encountered in the development of CP propellers for a ship of the FF 1052 Class which indicated that insufficient information was available on which to base a design for the power installed in the ships of this class. The work presented in this report has been performed as part of the research and development effort to obtain technical data on which to base more rational designs. More specifically, it is part of a project to investigate the blade loadings to be developed by CP propellers in normal operation.

The catastrophic failure of all the propeller blades on USS BARBEY (FF 1088)[1], which was fitted with a prototype controllable pitch (CP) propeller system, has revealed the need for further extensive investigation into the problems peculiar to high power CP propeller installations. There have also been reports that another ship fitted with a CP propeller similar in type to that on BARBEY encountered a high level of vibrations during manuevers. Therefore, a series of experiments to investigate change in blade loading is imperative as further installations of CP propellers, including the propellers on the DD 963 Class, are continuing.

It is known that the levels of propeller thrust and torque are significantly higher during turns than in straight ahead operation at a given speed of advance. During a turning maneuver, the wake distribution immediately ahead of the propeller becomes less uniform as the yaw angle of the ship increases. This nonuniformity may cause severe blade loads on a propeller. Since these blade loads may cause several structural problems and consequent material failures, it was considered important to investigate the character and level of these forces on a propulsive system during the turn. The wake survey data presented in this report are part of the experimental effort to determine variations in blade loading for CP propellers.

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[1]References are listed on page 14.

The objective of this phase of the work was to provide wake measurements on a model of the FF 1052 Class ship while in a turn in order to predict blade loads on the CP propeller. In addition, wake measurements with the model of FF 1052 Class were to be made with and without a dynamometer boat attached to the model to assess the effect of the dynamometer boat in experiments performed to actually measure the loads on a blade of a model controllable pitch propeller.[2]

The planned approach for this part of the project was to tow Model 4989, representing the FF 1052 Class, in a straight line and measure wake in way of the propeller disk both with and without the dynamometer boat. Then the model was to be towed in the Rotating Arm Tank to permit measurement of the wake in a turn. Finally, the model was to be towed with a yaw angle in a straight line in the Deep Water Basin to determine if the wake in the propeller disk in a turn can be approximated by the wake of a yawed model, thereby saving the extra cost of the Rotating Arm Facility if wake in turns were to be determined for other models.

EXPERIMENTAL PROCEDURE

All velocity surveys for this project were conducted using DTNSRDC Model 4989 which represents the FF 1052 Class ship. The model was fitted with bow sonar dome, bilge keels, roll-stabilizer fins, shaft and struts for all experiments. The particulars of size and loading for the ship and model are presented in Figure 1.

A pitot tube rake, DTNSRDC No. 7, and four differential pressure gages were used to measure the velocities in the plane of the propeller disk at each of five radial locations. The pitot tube rake consisted of 5-hole spherical pitot tubes mounted in a common housing. Figure 2 shows the arrangement of the rake and pitot tubes.

The full-scale propeller disk was 15.0 feet (4.572 m) in diameter. The radii at which the measurements were made, expressed as ratios of the propeller radius (r/R), were 0.330, 0.512, 0.711, 0.911, and 1.082. The propeller plane in which the velocity measurements were taken was 0.5 feet (0.15 m) forward of Station 19. To ensure the proper trim throughout the experiments the model was ballasted to a displacement corresponding to

4000 tons (4064 metric tons) and the trim corresponding to the sinkage and trim for the particular speed of interest. The model was locked at this condition of loading for all experiments.

In conducting an experiment, the runs are made at a constant speed, the input signals from the pitot tubes are integrated over a 5-second period and recorded digitally. Velocity component ratios are computed for each pitot tube and recorded. The rake is rotated to a new angle and the procedure is repeated until data are available throughout the entire propeller disk.

The circumferential distributions of the longitudinal, tangential, and radial velocity component ratios are plotted for each radial location then checked for random errors and conformity to values predicted from past experience. The mean longitudinal, tangential and radial component ratios of the velocity vectors, volumetric mean wake velocity ratio, mean and variations of values of the advance angle are also computed and plotted. Finally, analyses are performed to determine the harmonics of the circumferential distributions of the longitudinal and tangential velocity component ratios at both the experimental and interpolated radii. The amplitudes and phase angles for the first 10 harmonics of the longitudinal and tangential velocities are computed and presented in this report.

Table 1 presents a complete list of all experiments reported herein.

WAKE SURVEYS WITH AND WITHOUT A DYNAMOMETER BOAT-EXPERIMENTS 178 AND 179

A part of the overall project to determine blade loadings on CP propellers required the mounting of a dynamometer boat in close proximity to the stern of Model 4989 as shown in Figure 3. This photograph and the vast majority of the data and graphs presented in this report have been previously published in a report by Boswell, et al[2]. This material is republished in this report primarily for purposes of comparison with data from the other phases of the overall wake survey project.

Wake surveys were conducted with and without the dynamometer boat attached to Model 4989 at the standard conditions of displacement and trim previously specified in this report. The model speed for these experiments corresponded to 28.6 knots (14.7 m/sec) for the full-scale ship.

The experimental data in the form of velocity component ratios are listed in Appendix A. The circumferential distributions of the longitudinal, tangential, and radial velocity component ratios are presented as composite plots in Figures 4 through 7. The radial distributions of the mean velocity component ratios and of the mean advance angle are shown in Figures 8 and 9, respectively. The harmonics of the velocity component ratios for each experiment are presented in Appendix A.

The major difference between the velocity component ratios in the propeller plane with and without the dynamometer boat appears to be the change in the level of the longitudinal velocity component ratio (V_x/V). The value of V_x/V with the dynamometer boat is reduced by approximately 12 percent throughout the cirumference of the propeller disk. There is a tendency for the longitudinal harmonics with propeller boat to be larger, particularly for the higher (seventh to tenth) harmonics. The trend of these results is as anticipated.

WAKE SURVEYS IN TURNS-
EXPERIMENTS 180, 181, 182, AND 183

Experimental Conditions

The experimental conditions for the wake surveys in the rotating arm tank were derived primarily from full-scale tactical data measured during trials of the USS MEYERCORD (FF 1058) . The standard displacement and trim conditions for the model experiments are the same as listed previously. It was known prior to starting these experiments that the steady turn would by the only part of a typical turning maneuver which could be simulated within the limitations imposed by the Rotating Arm Carriage and the wake survey instrumentation. It was decided, therefore, to determine the steady (final) turning diameter, speed, and drift angle at midships for this part of the turn from full-scale data for several typical combinations of approach speed and rudder angles. The approach speeds and rudder angles chosen are listed in Table 2.

Experiments 180 and 181 correspond to the maximum loading expected on the propeller in a turn for this class ship, full power with 35 and 20 degree rudder angles, respectively. Experiments 182 and 183 correspond to trial conditions of the BARBEY during instrumented propeller trials. The first set of conditions, then, will provide a design extreme, and the second set will permit a correlation between values predicted from model data and those measured during full-scale trials.

Model 4989 was fitted for these experiments with DTNSRDC Pitot Tube Rake No. 7 in the usual manner, as described in the Introduction. Prior to conducting these experiments, the model was ballasted to the specified displacement (4000 tons (4064 metric tons)) and trim conditions and thereafter locked in place at the desired yaw angle at midships. Photographs of Model 4989 on the Rotating Arm Carriage during the conduct of Experiment 180 are presented in Figure 10.

The model was accelerated to a speed corresponding to the steady turning speed for the full-scale ship and measurements were taken to determine velocities at a number of angles in the plane of the propeller disk. Periodically measurements were repeated to be sure that no significant drifting of the data occurred. The data have been analyzed as described in the Introduction.

At the end of the Experiment 180 the preliminary data analysis indicated that the velocity component ratios determined for Tube 5 ($r/R = 1.082$) were not reasonable when compared to those for the other radial locations. The problem proved to be a blocked tube which was cleared in time to secure a full set of data for experiments 181 through 183. The data from Tube 5 have not been used in the analysis of data for Experiment 180 as they are obviously incorrect.

Individual data points from each of the four rotating arm wake surveys have been plotted as a function of circumferential position. From these data, the tangential and radial components have been combined to give a vector diagram of the in-plane velocities for each survey. This diagram shows clearly the significant cross-flow in the propeller plane and the resulting confused wake of the shaft and shaft struts.

The in-plane velocity vectors for Experiment 180 are plotted in Figure 11. Figures 12 through 15 present the circumferential distributions of

longitudinal, tangential, and radial velocity component ratios from Experiment 180. The radial distributions of circumferential mean velocities and advance angles are plotted in Figures 16 and 17 respectively.

Velocity data from Experiment 181 are presented in Figures 18 through 25 (arranged in a similar manner). Velocity data from Experiment 182 are presented in Figures 26 through 33. Velocity data from Experiment 183 are presented in Figures 34 through 41.

Appendix B presents the velocity component ratios for Experiments 180, 181, 182, and 183. Harmonic analysis have been performed on the longitudinal and tangential velocity component ratios for these experiments. Tables of the individual harmonic amplitudes and phase angles are also presented in Appendix B. The complete set of sixteen harmonics calculated for each experiment are presented for the four experimental radii and eight interpolated radii.

The calculated mean values of the advance angle (BBAR), and the maximum variations thereof (BPOS) and (BNEG) are shown in tables in Appendix B. The advance angles were calculated using an advance coefficient, J_V, of 0.800. A diagram showing the relationship between the longitudinal and tangential velocity vectors, the advance coefficient, and the advance angles is described on page xvii.

WAKE SURVEYS ON A YAWED MODEL TOWED IN A STRAIGHT LINE EXPERIMENTS 184 AND 185

Experimental Conditions

The purpose of these experiments was to determine whether the results from a model towed in a straight line with a drift (yaw) angle could be substituted for those in a turn as determined from the Rotating Arm Tests. The cost of running a model wake experiment in the Deep Water Basin is substantially less than the cost of the same experiment run in the Rotating Arm Facility. There is also the advantage that the model is not operating in its own wake as is the case in the Rotating Arm Facility.

The experimental conditions of yaw, speed in the turn, and rudder angle listed in Table 2 for the wake in turns were repeated as nearly as practicable for these experiments with the yawed model. The model was fitted with Rake No. 7 with the individual pitot tubes located at the same radius ratio as for the other experiments.

The yawed-model wake survey experiments corresponded to the Rotating Arm wake survey experiments as follows: Experiment 184 corresponds to Experiment 180 with respect to yaw angle and speed, Experiment 185 corresponds to Experiment 182 in similar fashion. Due to limitations of time, only the two wake surveys were run. Nevertheless, the similarity of the data from the four Rotating Arm surveys means that the comparison of yawed-model surveys in these two cases should be sufficient to show whether a yawed model survey can represent a model in a turn as simulated on the Rotating Arm.

The circumferential distributions of V_x/V, V_t/V and V_r/V are presented in graphical form for the wake experiments with the yawed model in Figures 42 through 55. Figures 42 through 46 present the circumferential distributions of longitudinal, tangential, and radial velocity component ratios from Experiment 184. The radial distributions of circumferential mean velocities and advance angles are plotted in Figures 47 and 48, respectively. Velocity data from Experiment 185 are presented in Figures 49 through 55 in a similar manner. Tabulations of the experimental data for values of r/R are listed in Appendix C. The results of harmonic analyses of the circumferential distributions of longitudinal and tangential velocity component ratios are also presented in Appendix C.

DISCUSSION OF RESULTS

The Bass Dynamometer Boat located behind the propeller plane of the model had a significant effect on the velocity component ratios in the propeller plane. The largest effect was shown in the longitudinal velocity component ratios. The restriction of flow caused by the dynamometer boat resulted in mean longitudinal velocity component ratios which were 0.147 to 0.101 lower than those without the boat. The differences in mean tangential velocity component ratios were very small, between 0.011 and 0.006, with no trend higher or lower.

The circumferential distribution of the velocity component ratios was not affected by the dynamometer boat. Figures 4 through 7 show that at every radius the effects of shaft wake, strut wake, and in the case of tangential and radial components the effects of flow upward from the

bottom of the hull, are the same with or without the dynamometer boat.

Hence, it may be stated that from these results the major effect of the Bass Dynamometer Boat on the wake in the propeller plane is a reduction in the longitudinal velocity component ratios due to the blockage caused by such a large bluff body behind the model.

The velocity component ratios from Experiment 180, which are considered typical of those from all the turning experiments, are compared with those from the usual type of wake experiment (in a straight line without dynamometer boat) and with those from the yawed model wake experiments in Figures 56 through 58 for the radius ratios of 0.512, 0.711, and 0.910. It may be noted from these figures that the changes in longitudinal velocity component ratio (V_x/V) are significant in that there is greater asymmetry for the model in a turn (ideally there should be none for the model towed in a straight line). There is also a greater wake defect behind the shaft and struts in the turn. The differences in tangential and radial velocity component ratios are much more significant than for V_x/V. Both circumferential distribution and amplitude of V_t/V and V_r/V have changed substantially for the turn compared to straight line operation.

As stated previously, there is a major limitation in conducting this type of experiment in the Rotating Arm Tank. By the time the model has been accelerated to the desired steady turning speed and data samples are integrated over a 5 second period, the model has turned more than 360 degrees, and is operating in its own wake. An attempt was made during these experiments to alter the sampling time to 1 second. The results from this attempt varied so much they were of little use. Evidently the transients in the flow are of sufficient duration that the full 5 second integration time is necessary. Data from specific points in the propeller disk were checked on several occasions to determine how well they repeated. In every case measurements were repeated within $\pm$ 1 percent which is the normal repeatability of the instrumentation based on calibration and past experience. Based on observations throughout the experiments, it would appear that, although the model is being towed in its own wake, that particular flow is quite constant. The error

in determining the wake in way of the propeller disk due to this effect is most probably constant from one experiment to another at the same speed. The change in level is also likely to be small compared to the rather sizeable changes in velocity component ratios noted from operating in a turn compared to operation straight ahead.

Some additional observations have been made in comparing the data from the wake survey experiments in a turn and in a straight ahead motion. The composite plots of velocity component ratios show that in a large portion of the propeller plane, the longitudinal velocity component ratio was not affected by the turn. In the area of the shafting and struts, however, a much greater effect is shown on the longitudinal velocity component ratios from the turning wake survey. This is probably due to the angle of flow into the appendages causing a much more significant variation in wake.

The largest changes in the velocity component ratios due to the turn are seen in the tangential and radial velocity component ratios. The high angularity of the flow leads to much greater peaks in the circumferential distribution of these components. This effect is shown clearly in Figures 56 through 58. Because circumferential distributions of tangential and radial components were so radically different they were plotted as "in-plane" vectors in Figures 11, 18, 26, and 34. Looking at Figure 11 for example, the cross-flow caused by the combination of drift angle and turning clearly stands out. In addition, the confused flow in the wake of the appendages is seen in the vectors along the 270-degree and 300-degree radial lines in Figure 11.

The conclusion to be drawn from these data is that when the model is towed in a straight-ahead condition the major effect on the variation of the in-plane velocity components (tangential and radial) is due to the upward flow from the bottom of the hull. In the turning condition, however, the major effect on in-plane velocities is due to the cross-flow caused by the drift angle and the turning path. The maximum tangential or radial velocity component ratios in a turn can be as high as three times that of the same model in straight-ahead motion. In fact, the amplitude of the first harmonic of the tangential velocity component ratios at the 0.7 radius is 2.5 times higher for the turning condition.

Although the changes in velocity component ratios are quite dramatic the effect on β angles is small. For example, the circumferential mean β angle for the turning wake survey is less than that for the straight-ahead survey but by less than one degree. The total variation in β ($|+\Delta\beta| + |-\Delta\beta|$) angle is 1.3 degrees greater for the turning wake survey than for the straight-ahead survey. These comparisons are shown in Table 3 in which the data from the wake survey on the rotating arm is presented along with data from the straight-ahead (conventional) wake survey and the yawed-model wake survey.

The attempt to represent the wake of a model which is in a turn on the rotating arm by running a model in the straight towing tank with a drift angle was unsuccessful. As may be seen from the velocity component ratios plotted in Figures 56 through 58, the magnitude and the distribution of velocity component ratios are completely different for the yawed model. In fact, the longitudinal velocity component ratio was actually lower in the case of the yawed model towed in a straight line than for either the straight wake survey or for the turning wake survey. Presumably the wake of the hull had a much larger effect on the velocities in the propeller plane in this case. The wake variations due to the shaft and struts are greater than for the conventional straight wake survey but not nearly as dramatic as those of the turning wake. In short, it may be noted that the yawed condition gives a result that is neither like that of the turning condition nor of the straight-ahead condition. Perhaps such data may be used to analyze the initial portion of a turn, before the hull takes on an angular path or to analyze a pure drifting motion where the hull has some steady drift angle. If the conditions during a steady turn are to be studied, however, the wake data must be obtained from a survey performed on the rotating arm.

At this point, it should be pointed out that there are some limitations on the usefulness of the five-hole pitot tube and associated instrumentation in performing a velocity survey in the propeller plane. As Hadler and Cheng[3] have shown, the velocities to be measured must be large enough to obtain significant pressure differences. In all cases, this condition is met by the data reported herein. However, it is known that the five-hole

pitot tube cannot distinguish between a shear flow and a flow from an angle. Since the formation of a shear flow usually involves a boundary layer on a hull surface and since the surveys reported herein are performed in a more open flow behind shaft and struts, there appears to be very little effect on the pitot tube measurement. The large in-plane velocities are in fact due to angularity of the in-flow velocity.

The major limitation on the data reported herein is the fact that these data represent a steady condition. Because the pressure-measuring system is unable to respond to instantaneous changes, as mentioned in the discussion of the rotating arm wake surveys, all data obtained in these experiments are for a steady-state condition. Therefore, the results do not represent any transient conditions which may arise during the execution of a turn. Finally, the data reported herein have been calculated using the calibrations of the five-hole pitot tubes performed in the straight tank. When the pitot tubes were recalibrated on the rotating arm for another experiment, it was found that the calibrations were similar to within a small percentage. Recalculation of a sample set of data using the two different calibrations showed differences in the order of 0.01 to 0.02 on the velocity component ratios. Since these differences were of the order of the experimental accuracy, the rotating arm data were not recalculated. The data are considered valid to within plus or minus 0.2 in all cases.

SUMMARY AND CONCLUSIONS

Three sets of wake survey experiments have been performed on a model of the FF 1052 Class ship. Experiments were performed to measure the effect on propeller disk wake of a Bass Dynamometer Boat mounted downstream of the model, the effect of a steady turn, and the effect of a model towed in a straight line with a drift angle. Data from the first two series were required for calculation of propeller forces and data from the third were obtained to determine if the turning condition could be simulated without the use of a rotating arm.

The Bass Dynamometer Boat significantly lowered the longitudinal velocity component ratios due to blockage of the flow. The circumferential distribution of velocity component ratios was not altered by the presence of the dynamometer boat downstream.

The turning wake surveys performed on the Rotating Arm Facility showed very large changes in the tangential and radial velocity component ratios due to the large cross-flow in the propeller plane. The wake due to the shaft and the struts was more extreme in the case of the turning wake surveys. The first harmonic of tangential velocity component ratios was increased 2.5 times that of a straight-ahead condition.

The results of the yawed-model wake surveys in the straight tank did not reproduce the results of the rotating arm turning wake surveys. The peak values of tangential and radial velocity component ratios are approximately midway between the peak values of the turning wake survey and the conventional straight ahead survey. The longitudinal velocity component ratio for the yawed model towed straight ahead showed a larger value than the other two surveys due presumably to the wake of the hull.

These data may be used in calculations of propeller forces for a controllable pitch propeller in steady motion. The data from the survey with the dynamometer boat may be used for calculation of propeller forces which then may be compared with the results of measurements. The calculation of propeller forces and the measurements have been reported separately.

ACKNOWLEDGEMENTS

The authors are indebted to personnel of the Ship Performance Department of DTNSRDC. Special appreciation is extended to Mr. Robert Roddy for conducting the wake surveys with and without a bass dynamometer boat, and Mr. Alan C. M. Lin for performing the wake surveys on a yawed model in a straight line. The authors also wish to thank Mr. Charles J. Wilson of Operations Research Incorporated for his assistance in the preparation of this report.

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2. Boswell, R. J., et al, "Experimental Unsteady and Mean Loads on a CP Propeller Blade on a Model of the FF-1088 for Simulated Modes of Operation," DTNSRDC Report 76-0125 (Oct 1976).

3. Hadler, J. B. and H. M. Cheng, "Analysis of Experimental Wake Data in Way of Propeller Plane of Single- and Twin-Screw Ship Models," Transactions of Society of Naval Architects and Marine Engineers, Vol. 73, (1963).

	Ship		Model	
Length at Waterline	126.6 m	415.3 ft	6.486 m	21.28 ft
Beam	14.17 m	46.5 ft	0.727 m	2.385 ft
Draft	4.57 m	15.0 ft	0.234 m	0.769 ft
Displacement	4.064×10^6 Kg(S.W.)	4000 tons (S.W.)	532.4 Kg(F.W.)	0.524 tons (F.W.)

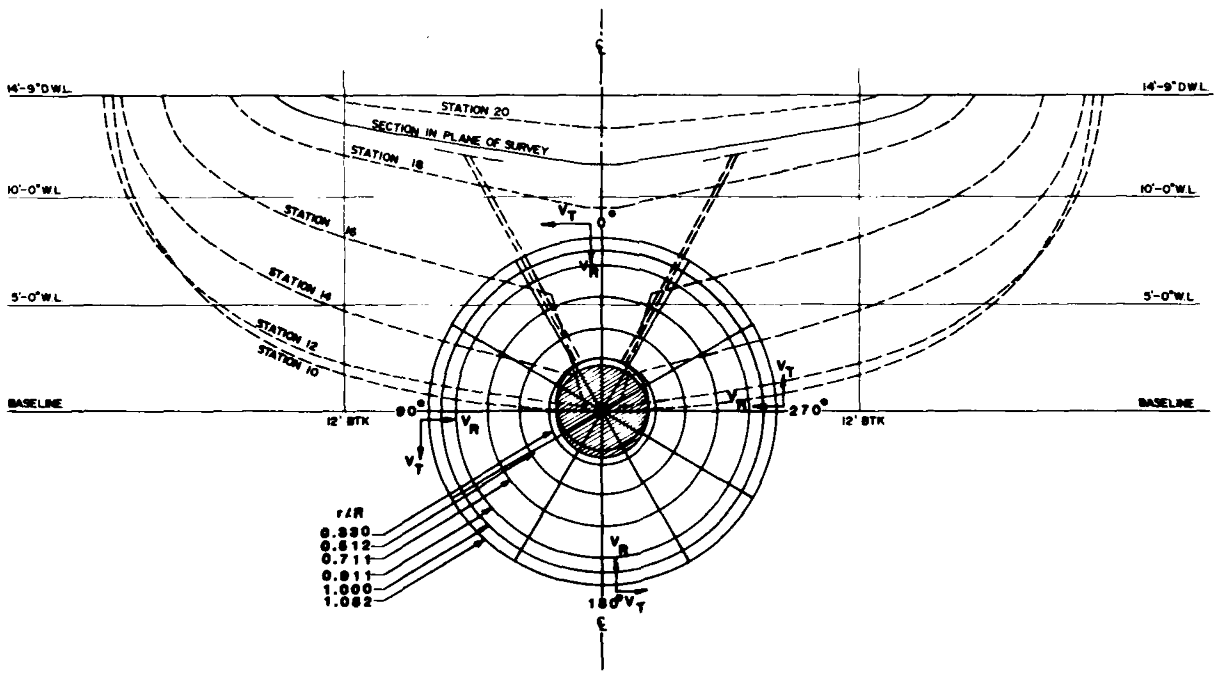


Figure 1 - Ship and Model Particulars for FF1088 Represented by Model 4989

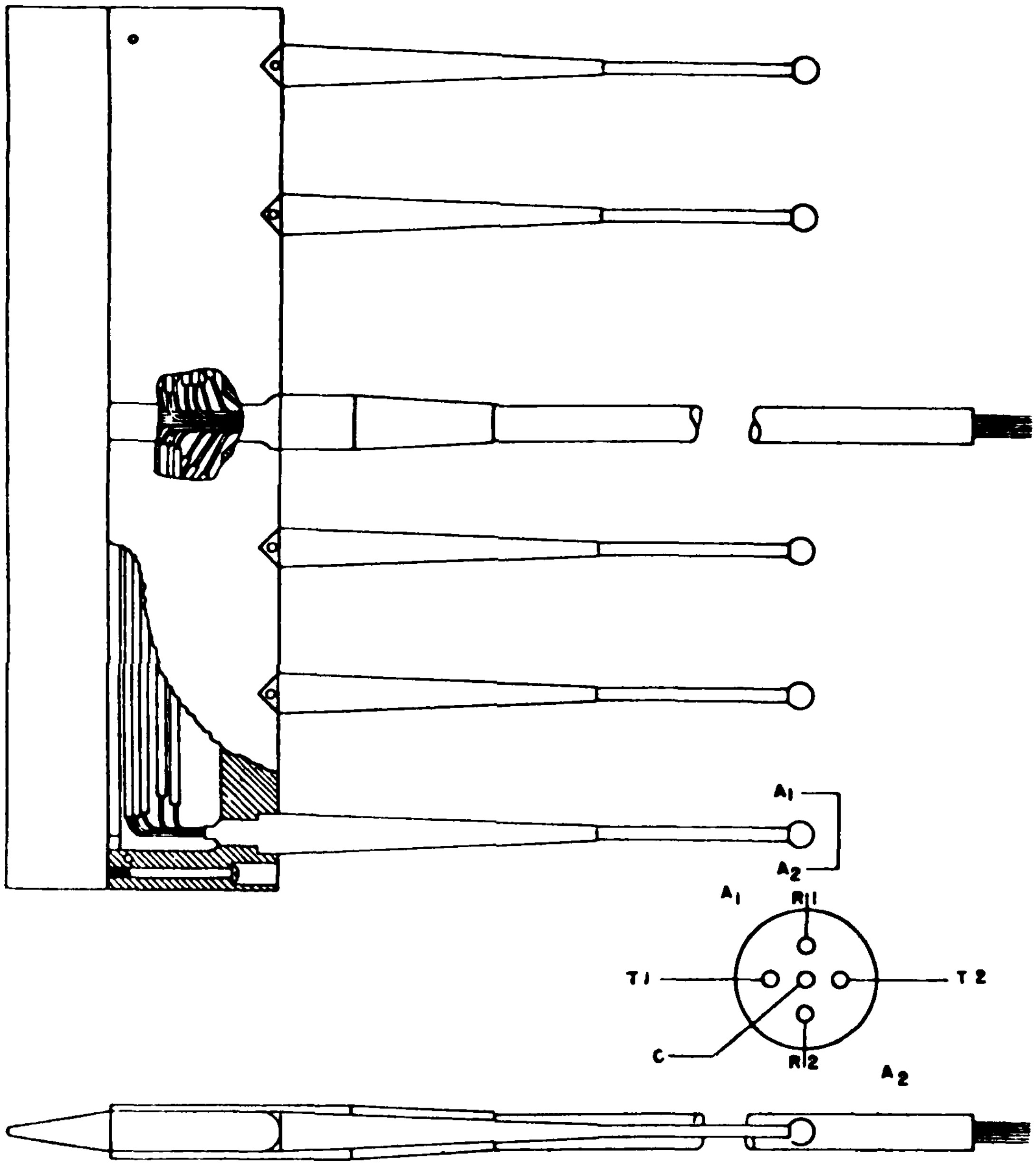


Figure 2 - Rake Arrangement Showing Spherical Head Pitot Tubes

Figure 3 - Experimental Arrangement of Model 4989 and the Bass Dynamometer Boat

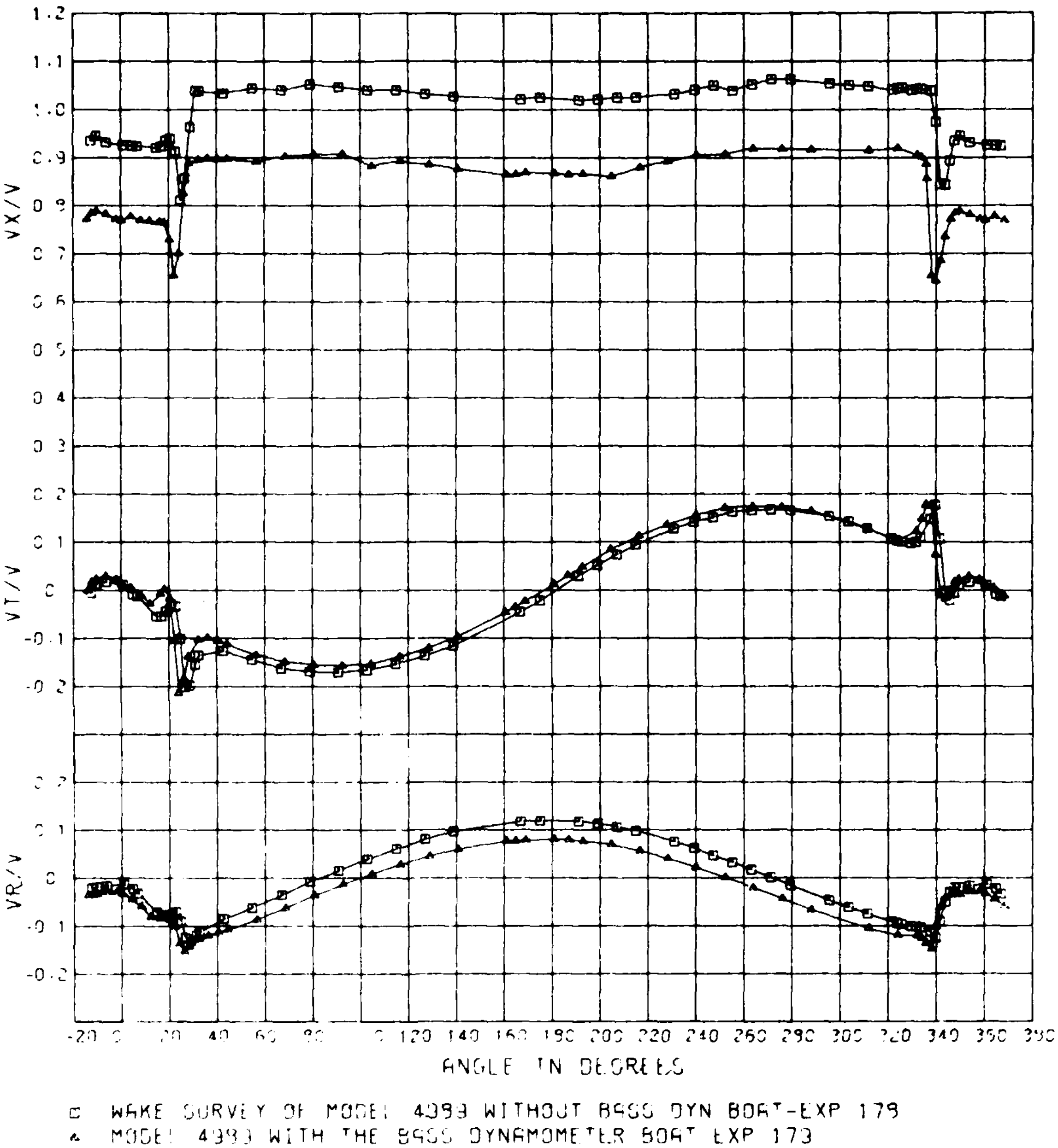


Figure 4 - Composite Plot of Velocity Component Ratios from Experiments With and Without the Bass Dynamometer Boat for the 0.512 Radius

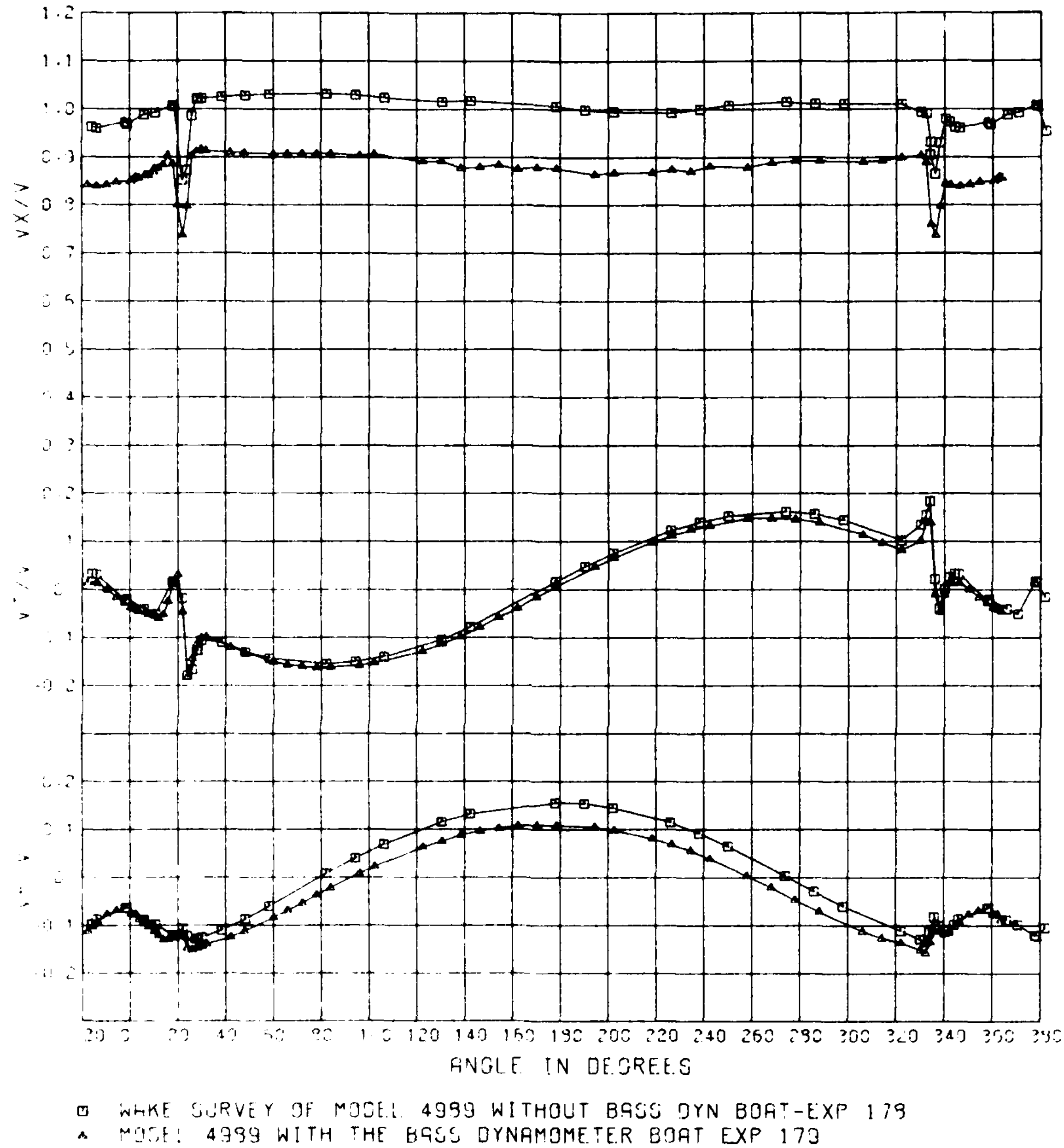


Figure 5 - Composite Plot of Velocity Component Ratios from Experiments With and Without the Bass Dynamometer Boat for the 0.711 Radius

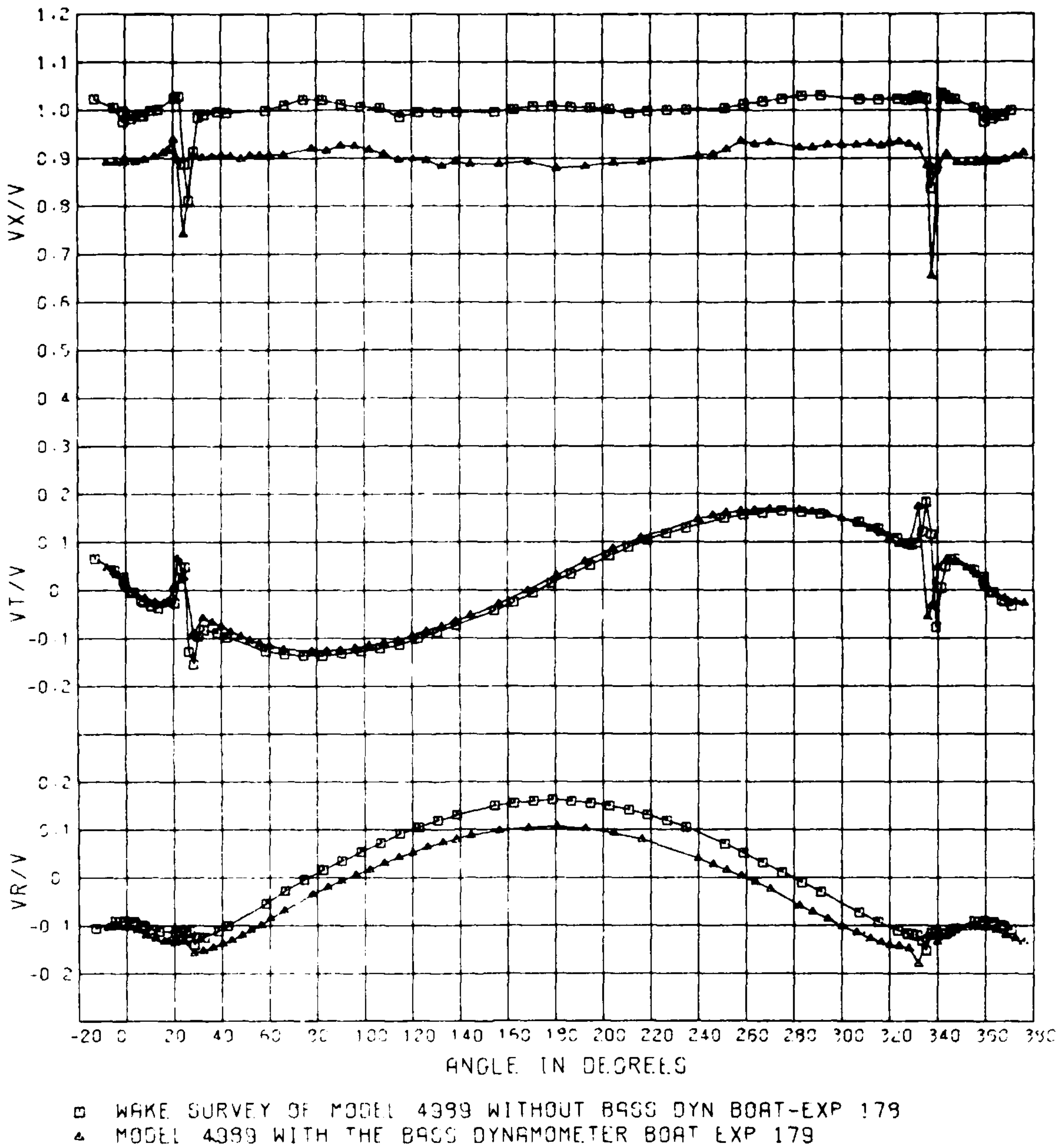


Figure 6 - Composite Plot of Velocity Component Ratios from Experiments With and Without the Bass Dynamometer Boat for the 0.910 Radius

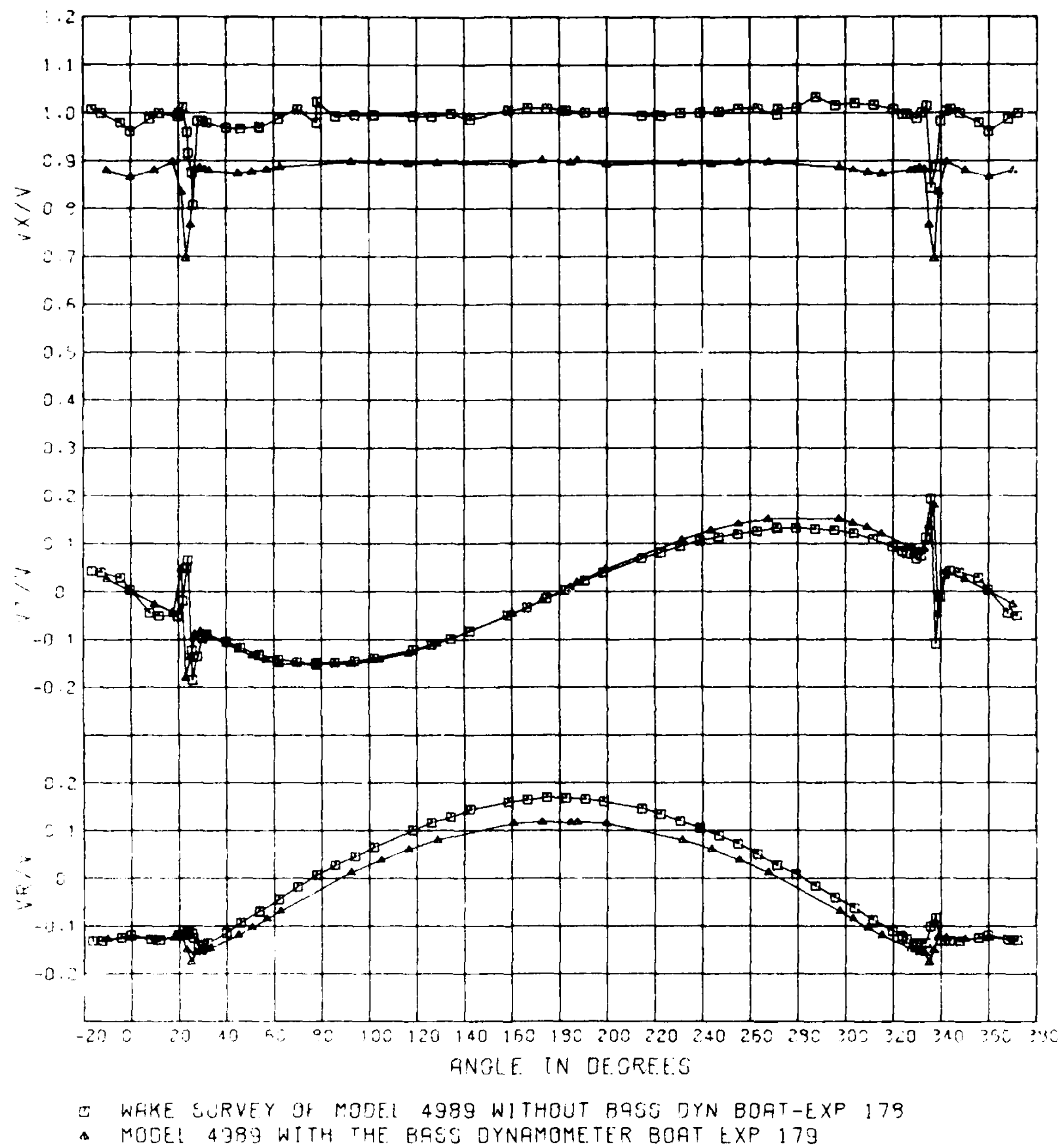


Figure 7 - Composite Plot of Velocity Component Ratios from Experiments With and Without the Bass Dynamometer Boat for the 1.082 Radius

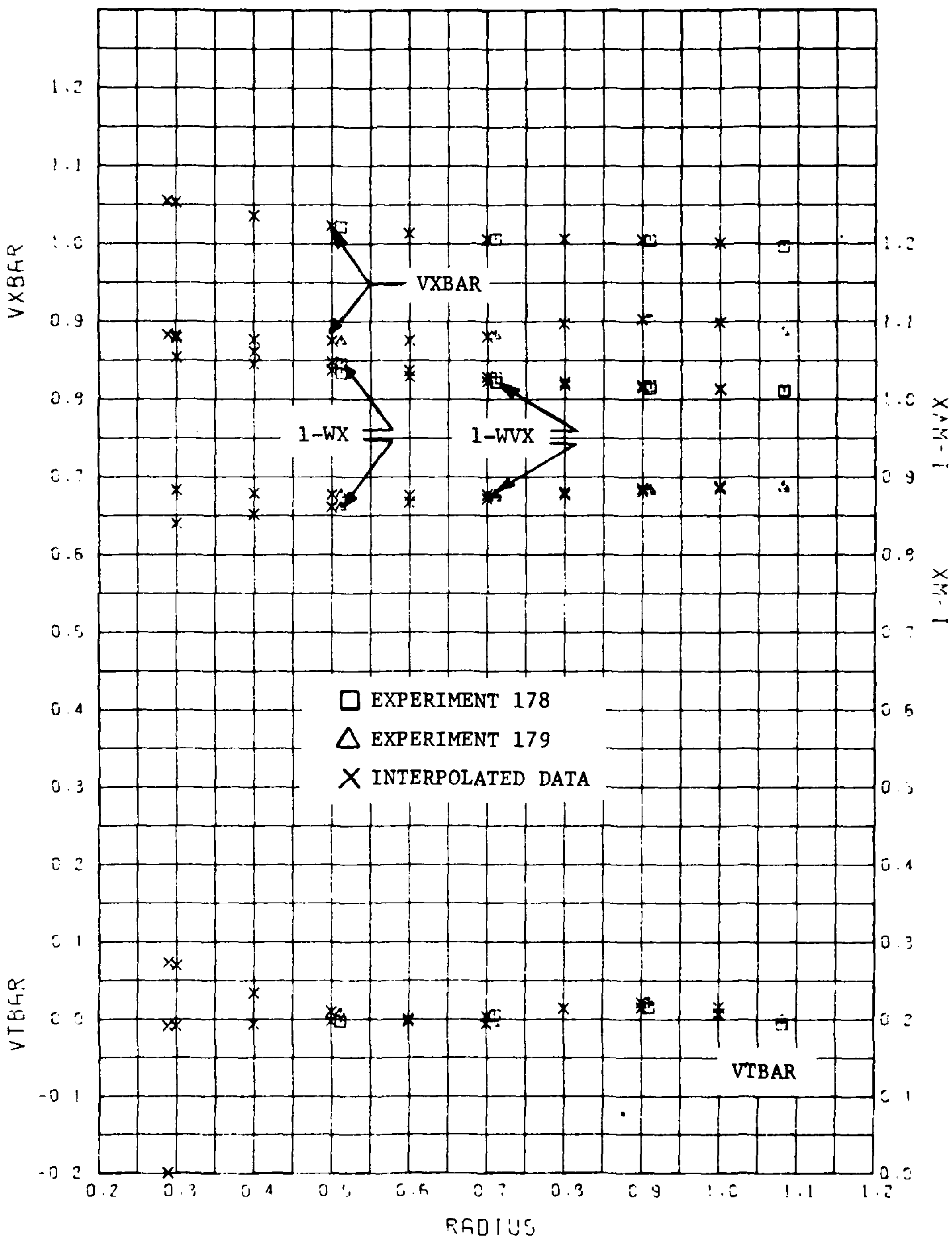


Figure 8 - Composite Plot of Mean Longitudinal, Tangential, and Volumetric Mean Wake from Experiments With and Without the Bass Dynamometer Boat

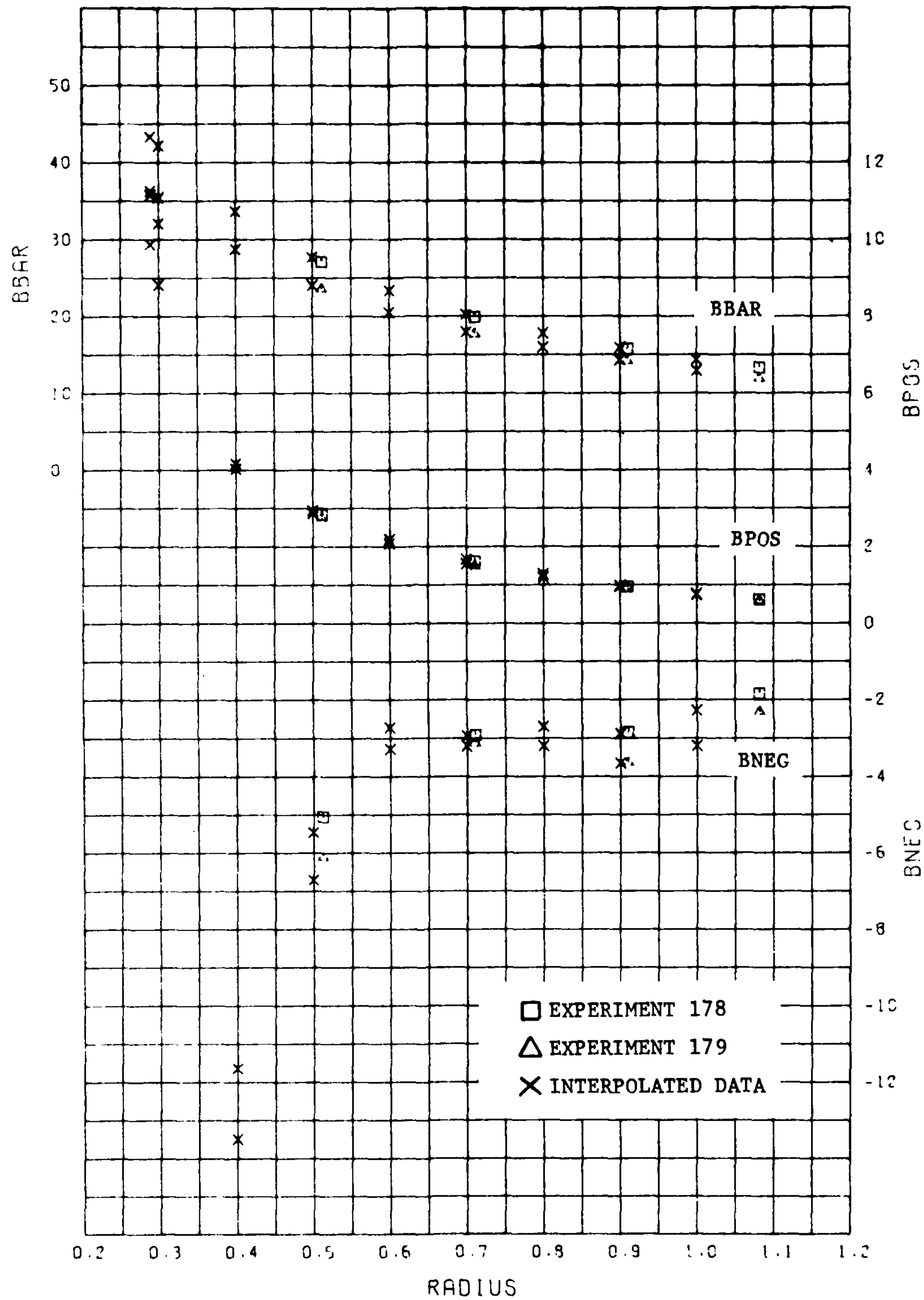
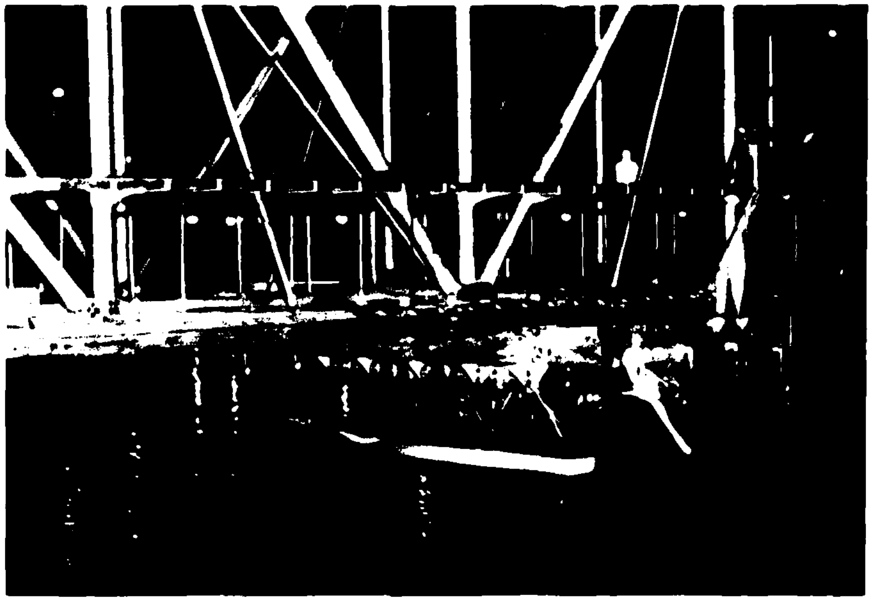


Figure 9 - Composite Plot of Mean Advance Angle (Beta) and Maximum Variations of Advance Angle from Experiments With and Without the Bass Dynamometer Boat



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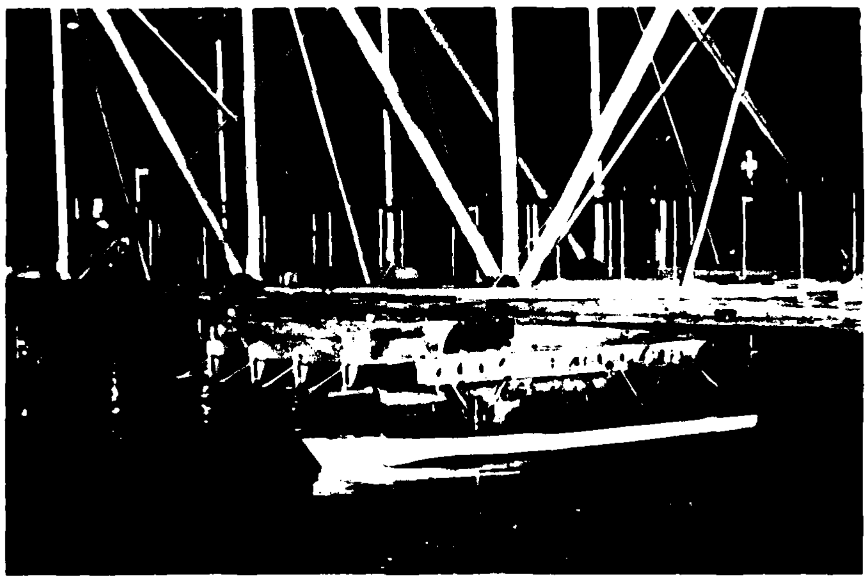


PSD 344220

Figure 10 - DTNSRDC Model 4989 Attached to the Rotating Arm

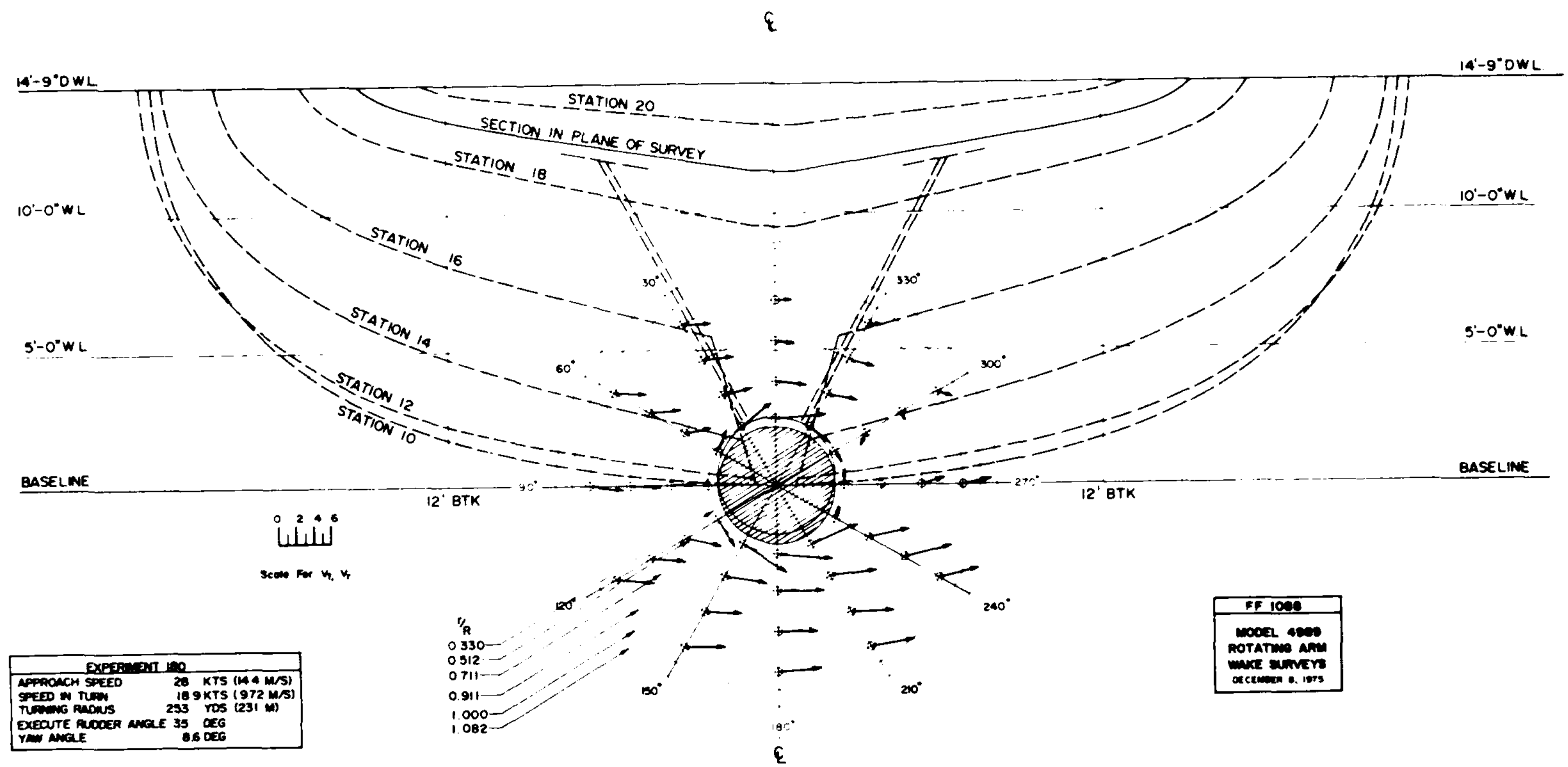


Figure 11 - Velocity Vector Diagram of the Flow In the Propeller Plane for Experiment 180

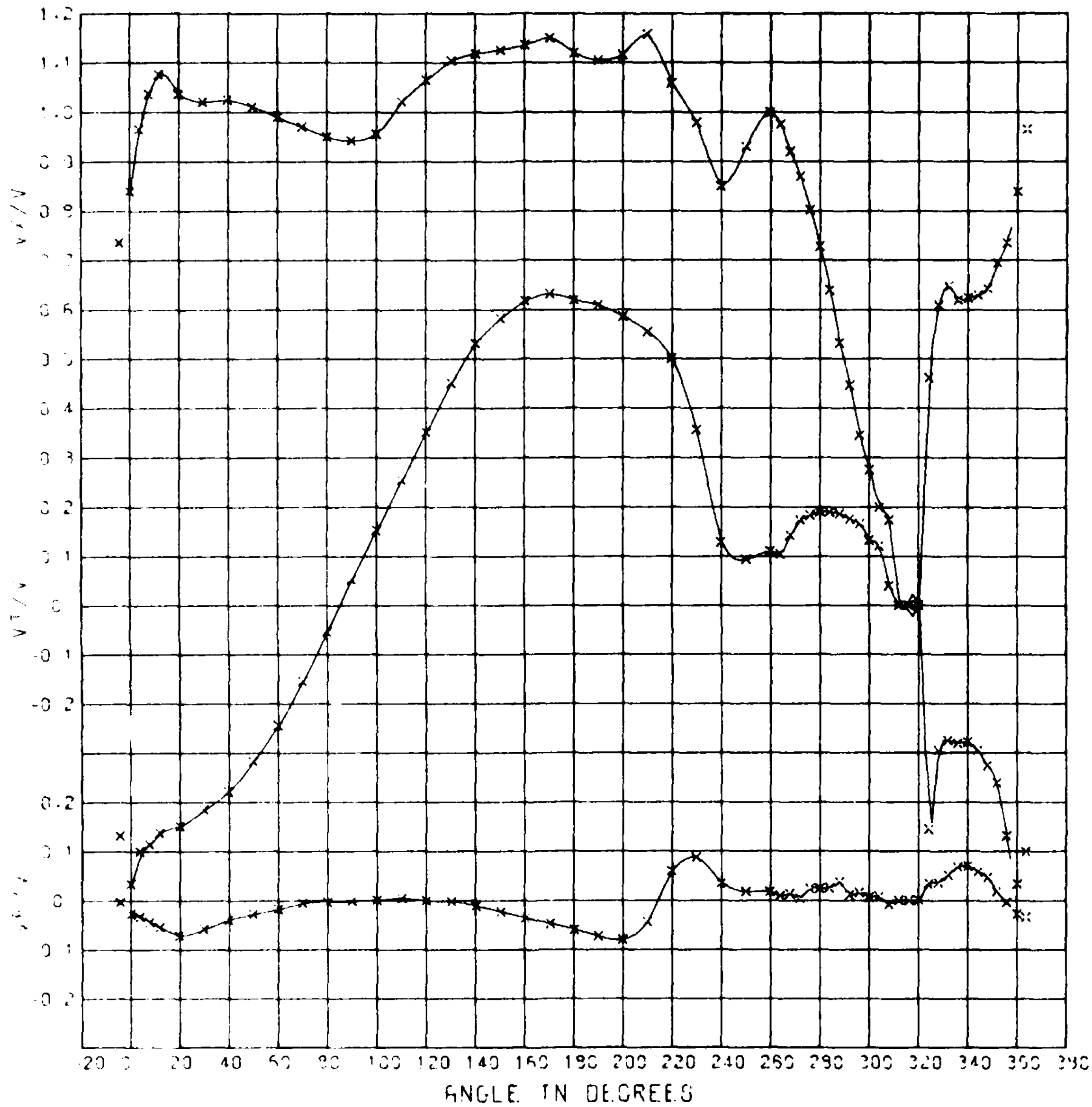


Figure 12 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = .330 for Experiment 180

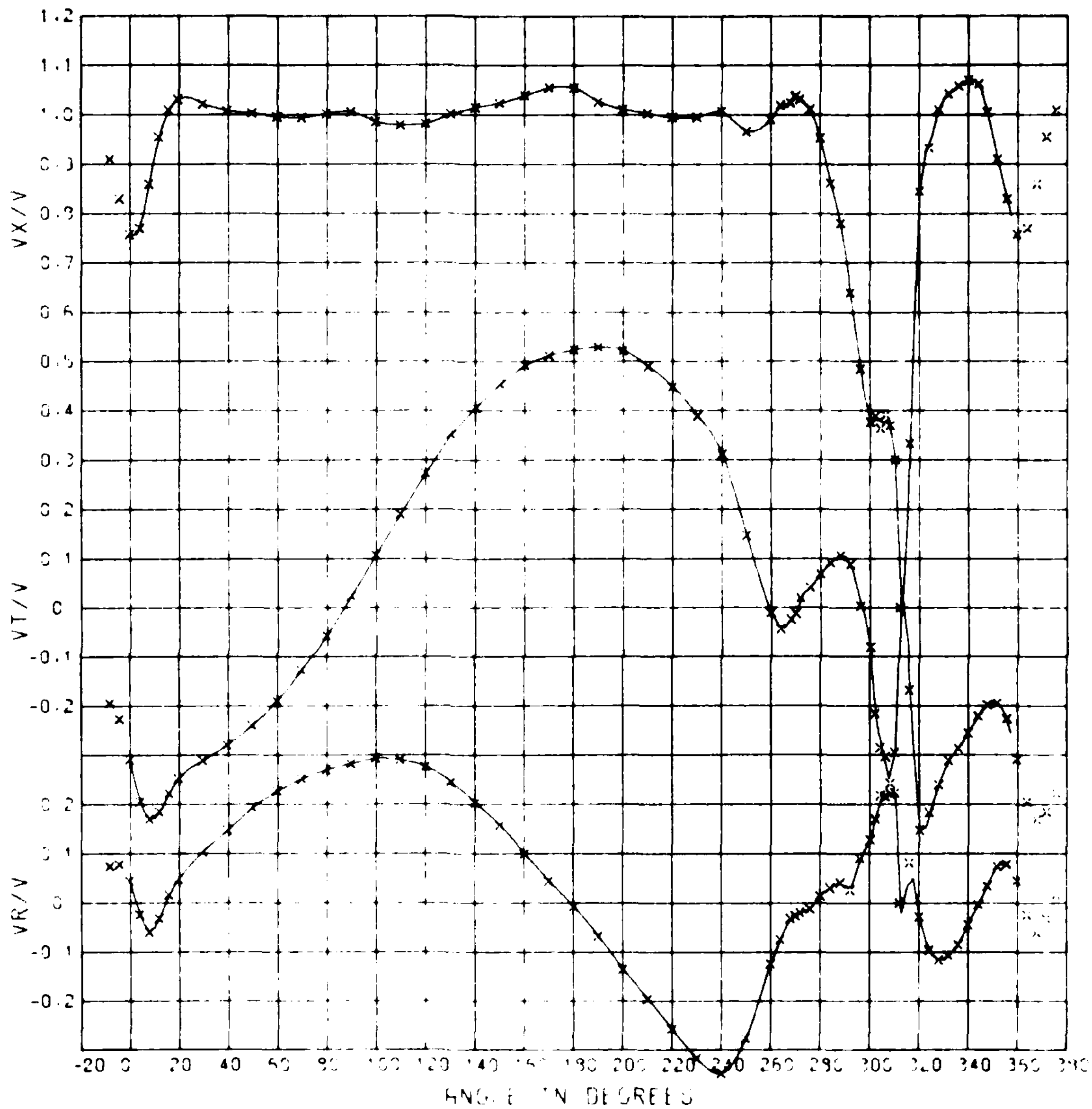


Figure 13 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = .512 for Experiment 180

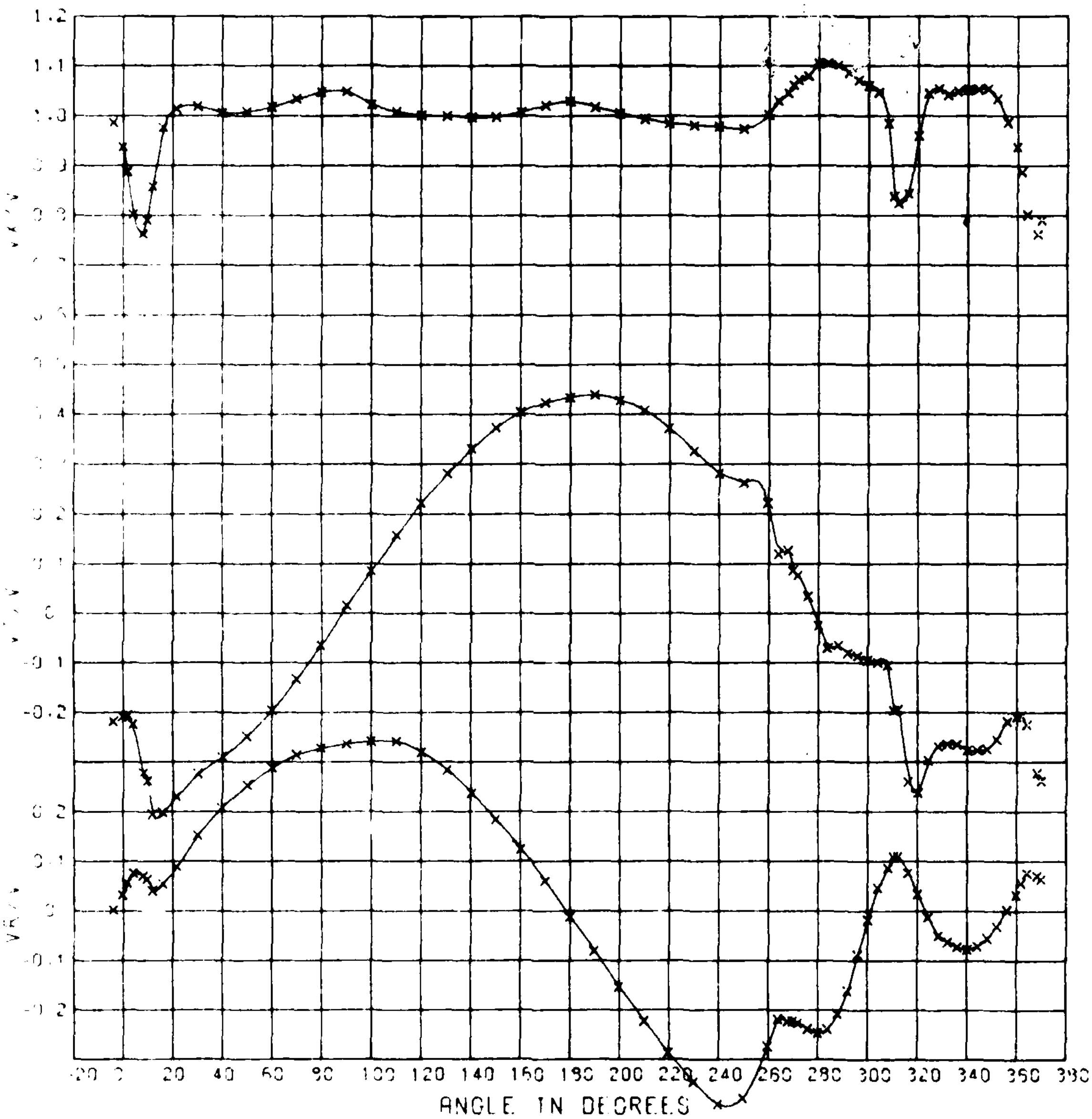


Figure 14 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.711 for Experiment 180

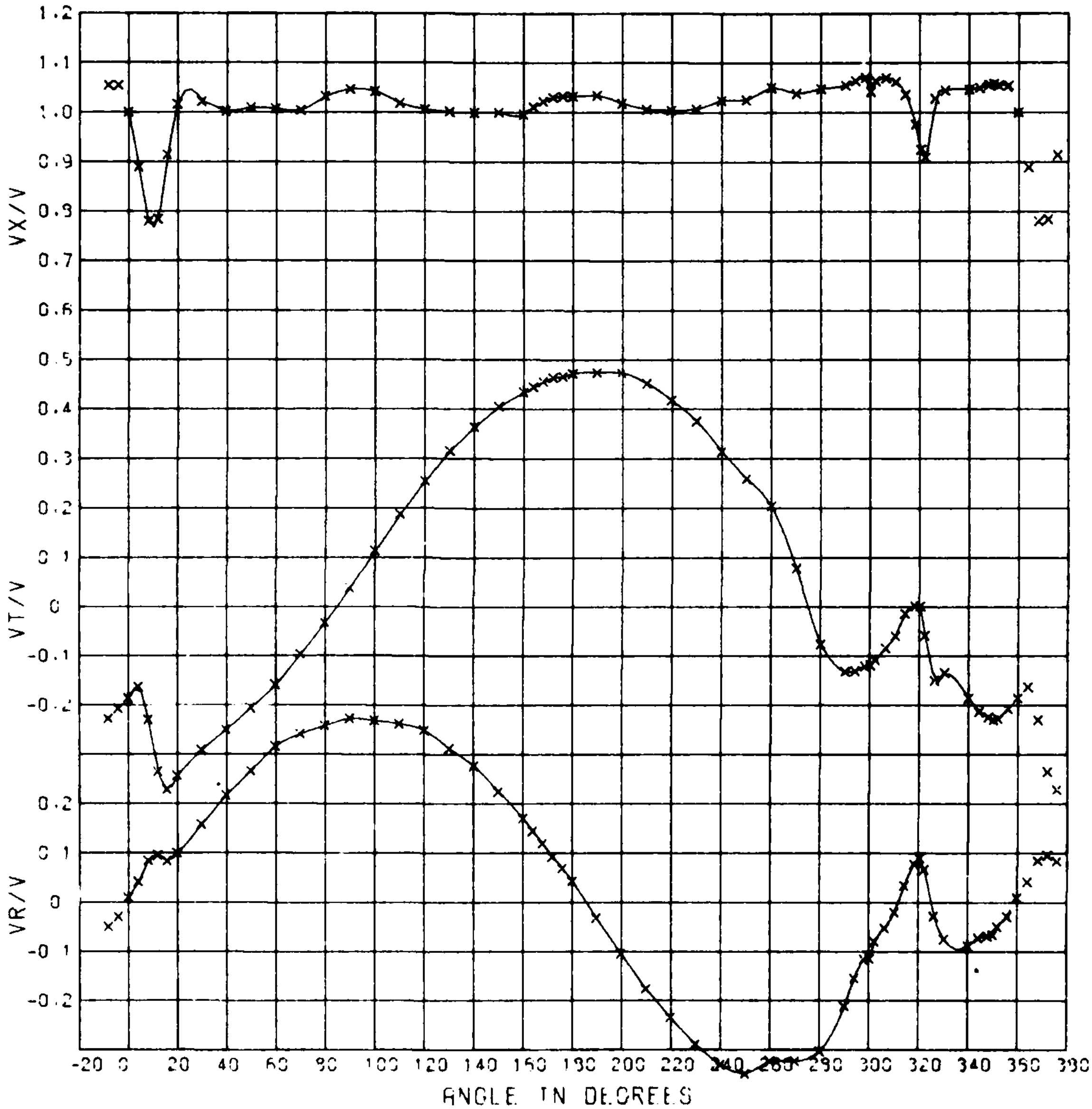


Figure 15 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.911 for Experiment 180

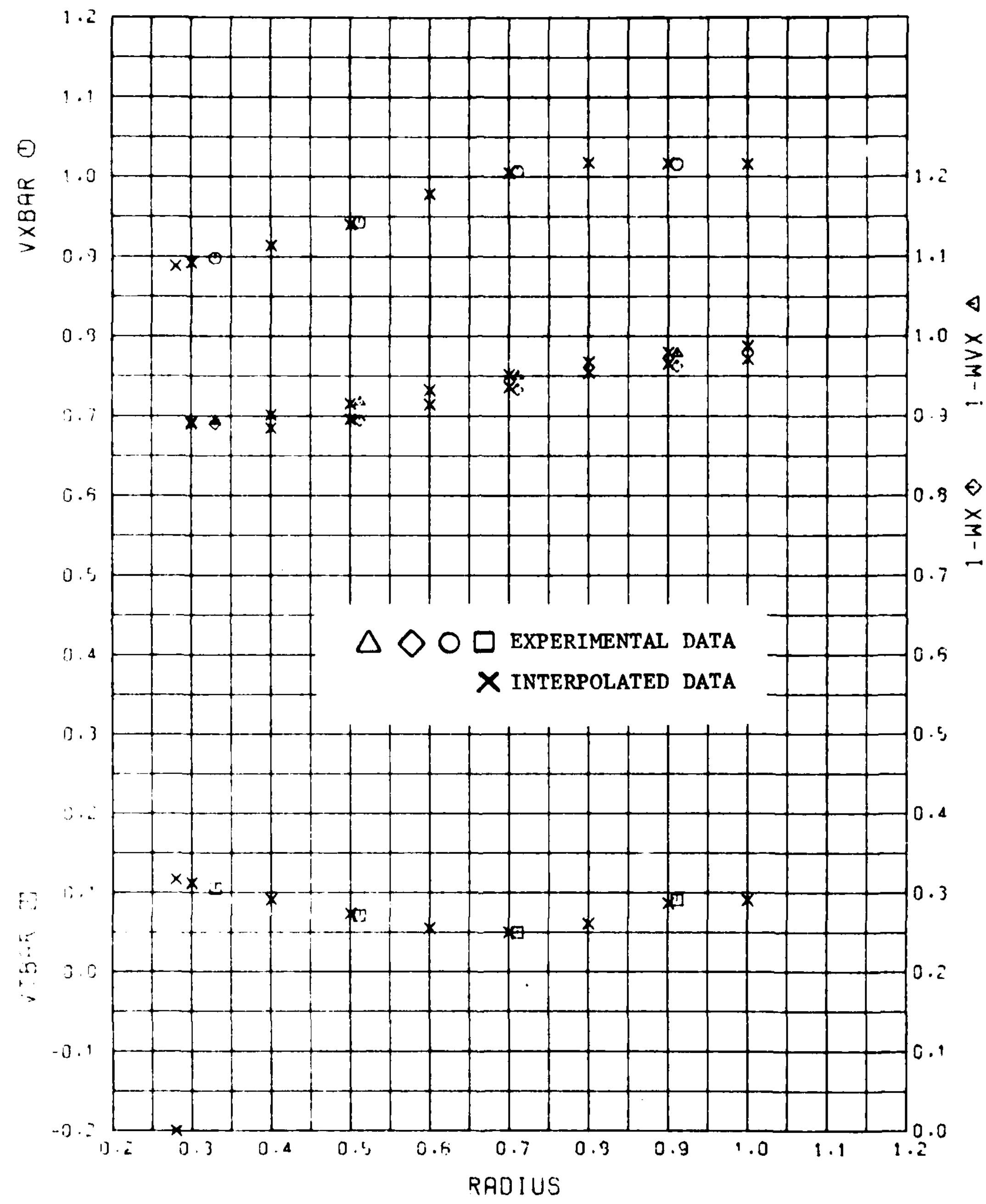


Figure 16 - Radial Distribution of the Mean Velocity Component Ratios for Experiment 180

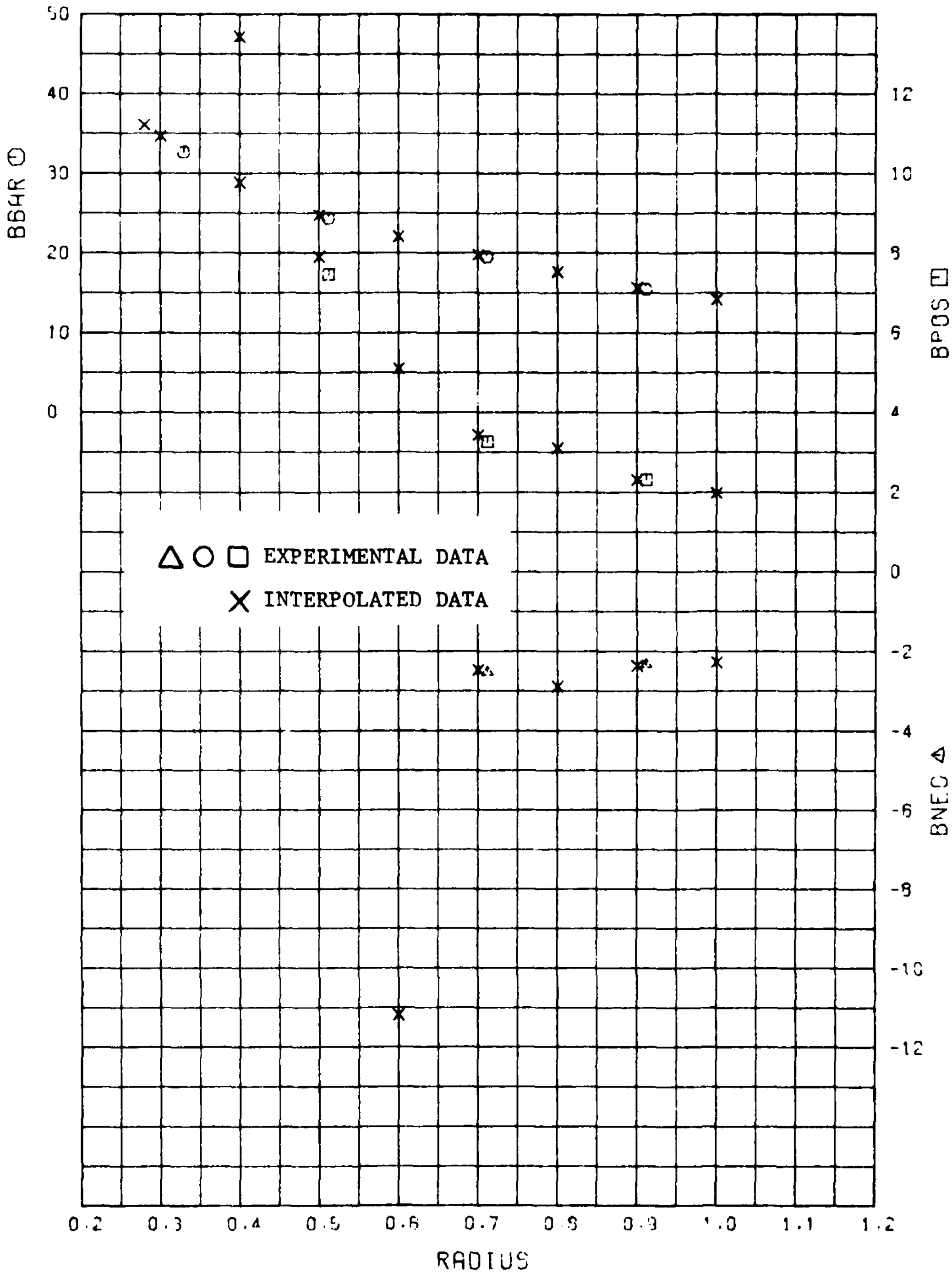


Figure 17 - Radial Distribution of the Mean Advance Angle and Advance Angle Variations for Experiment 180

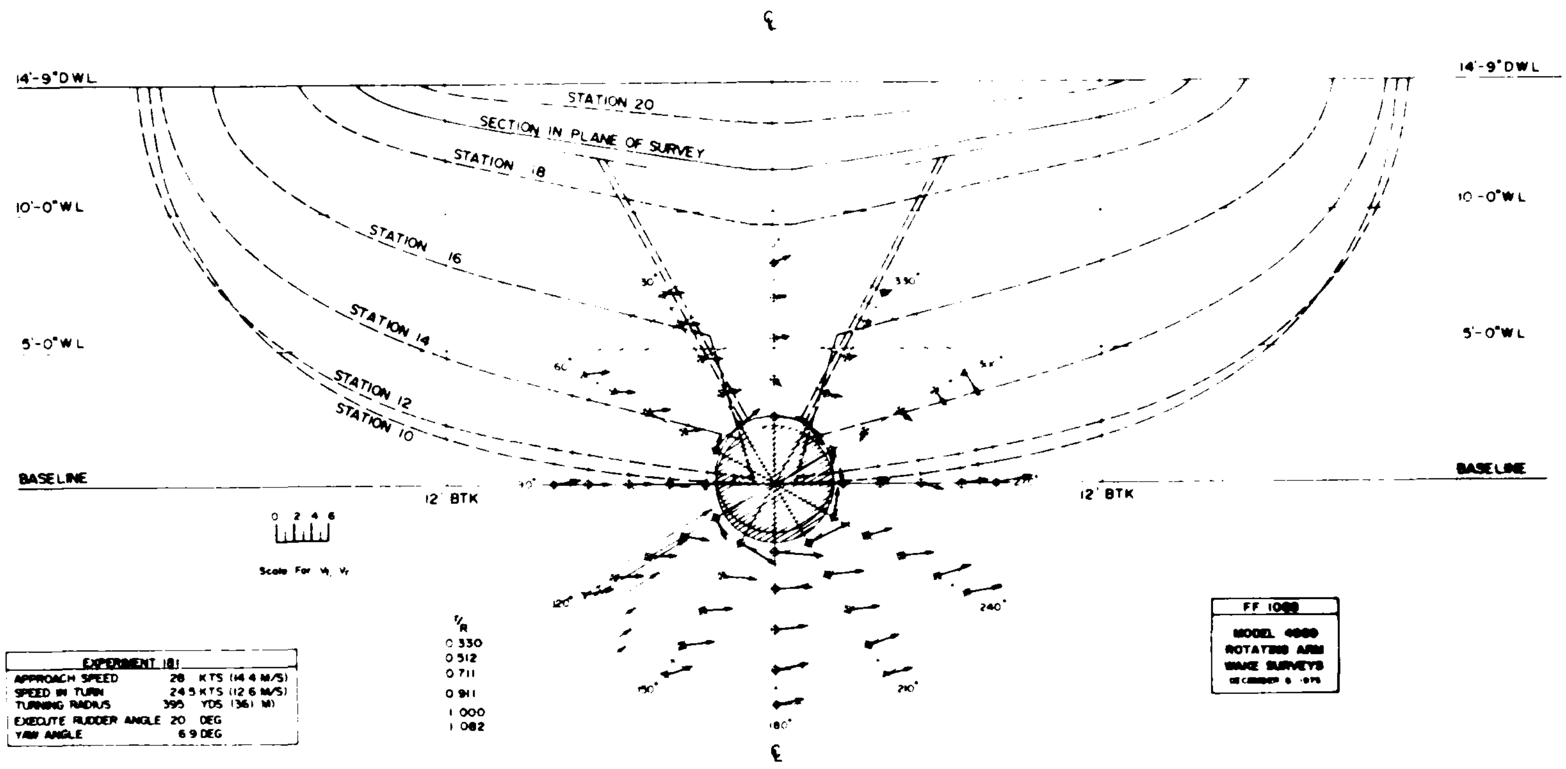


Figure 18 - Velocity Vector Diagram of the Flow In the Propeller Plane for Experiment 181

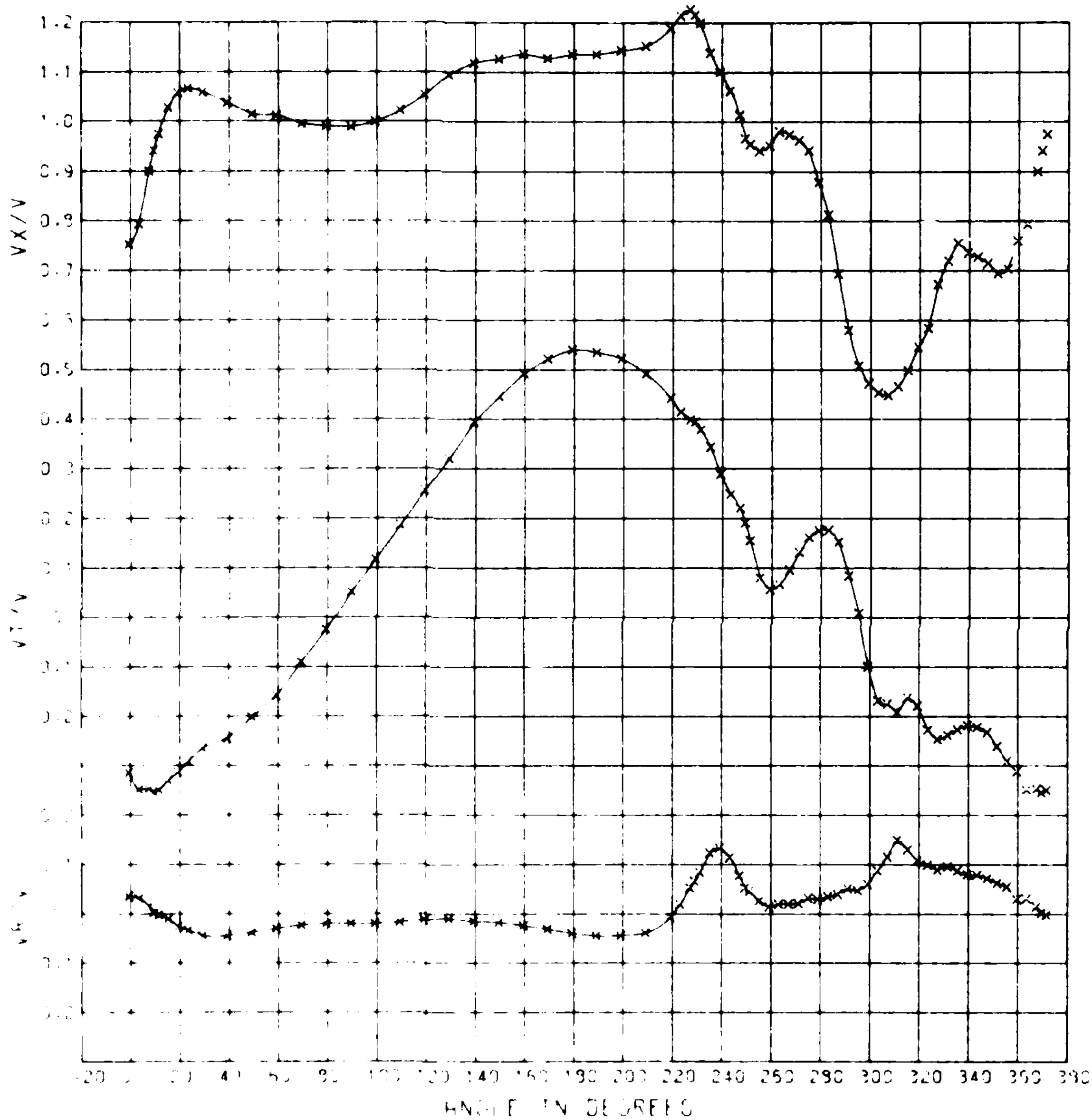


Figure 19 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.330 for Experiment 181

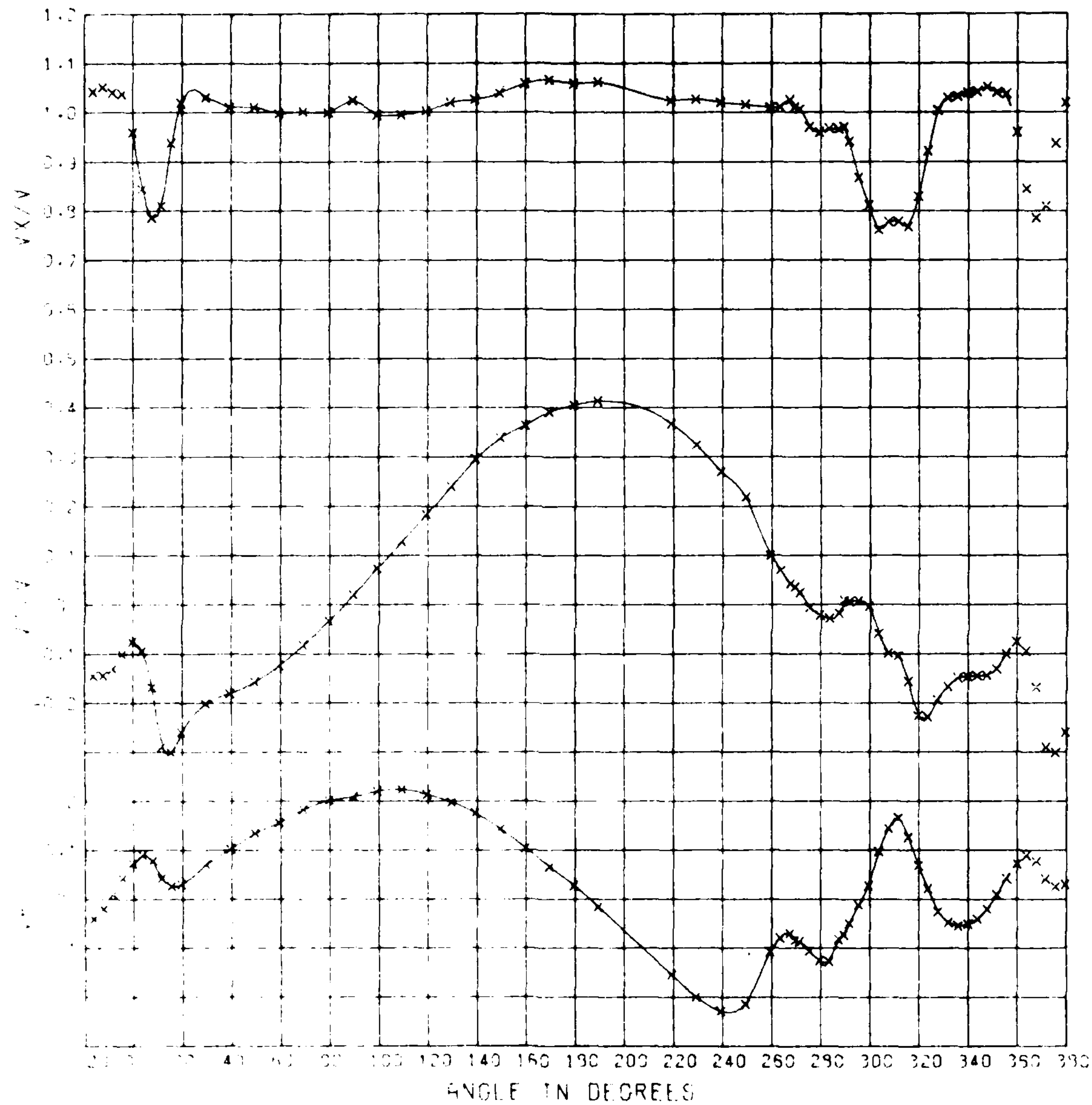


Figure 20 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.512 for Experiment 181

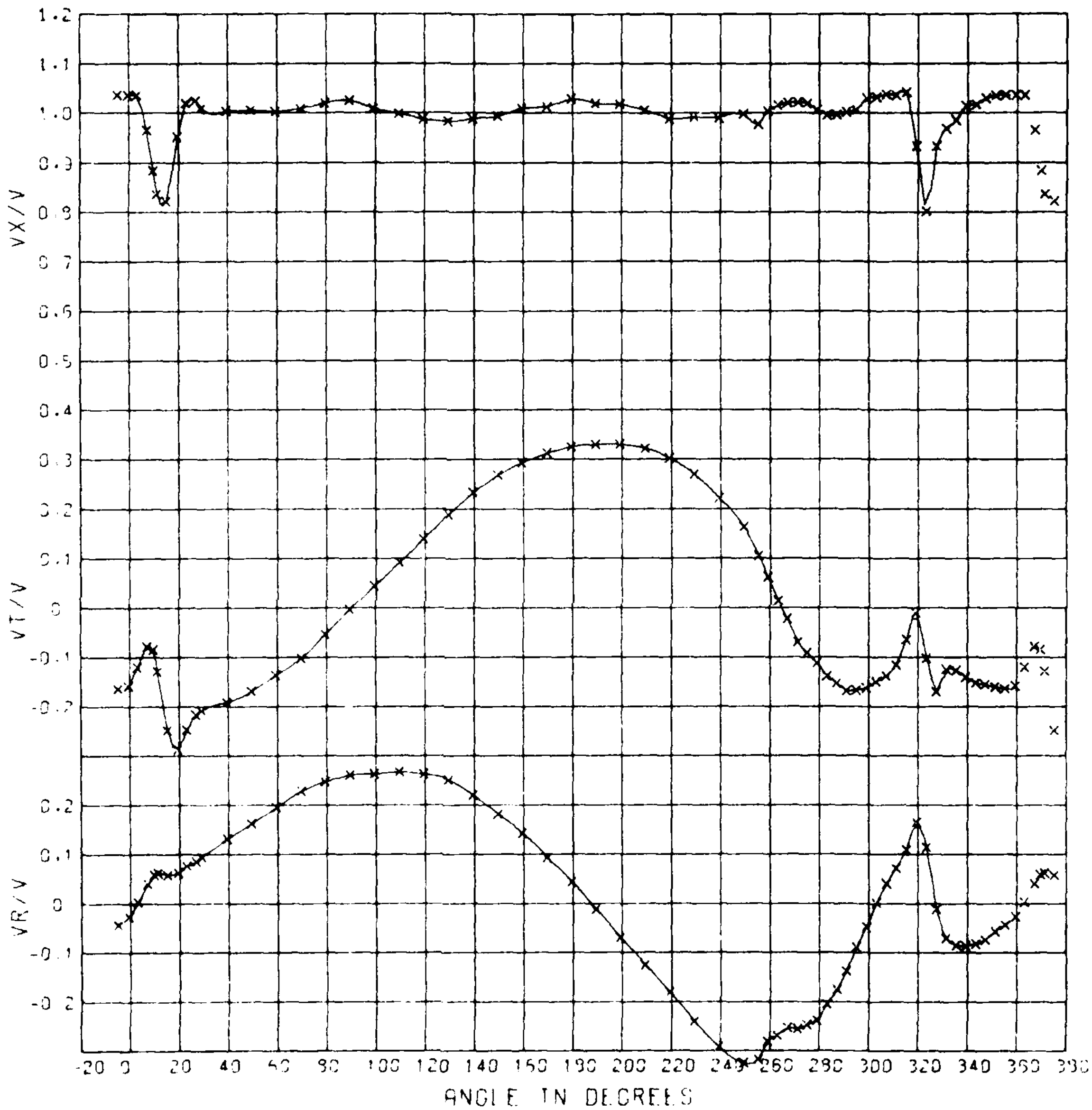


Figure 21 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.711 for Experiment 181

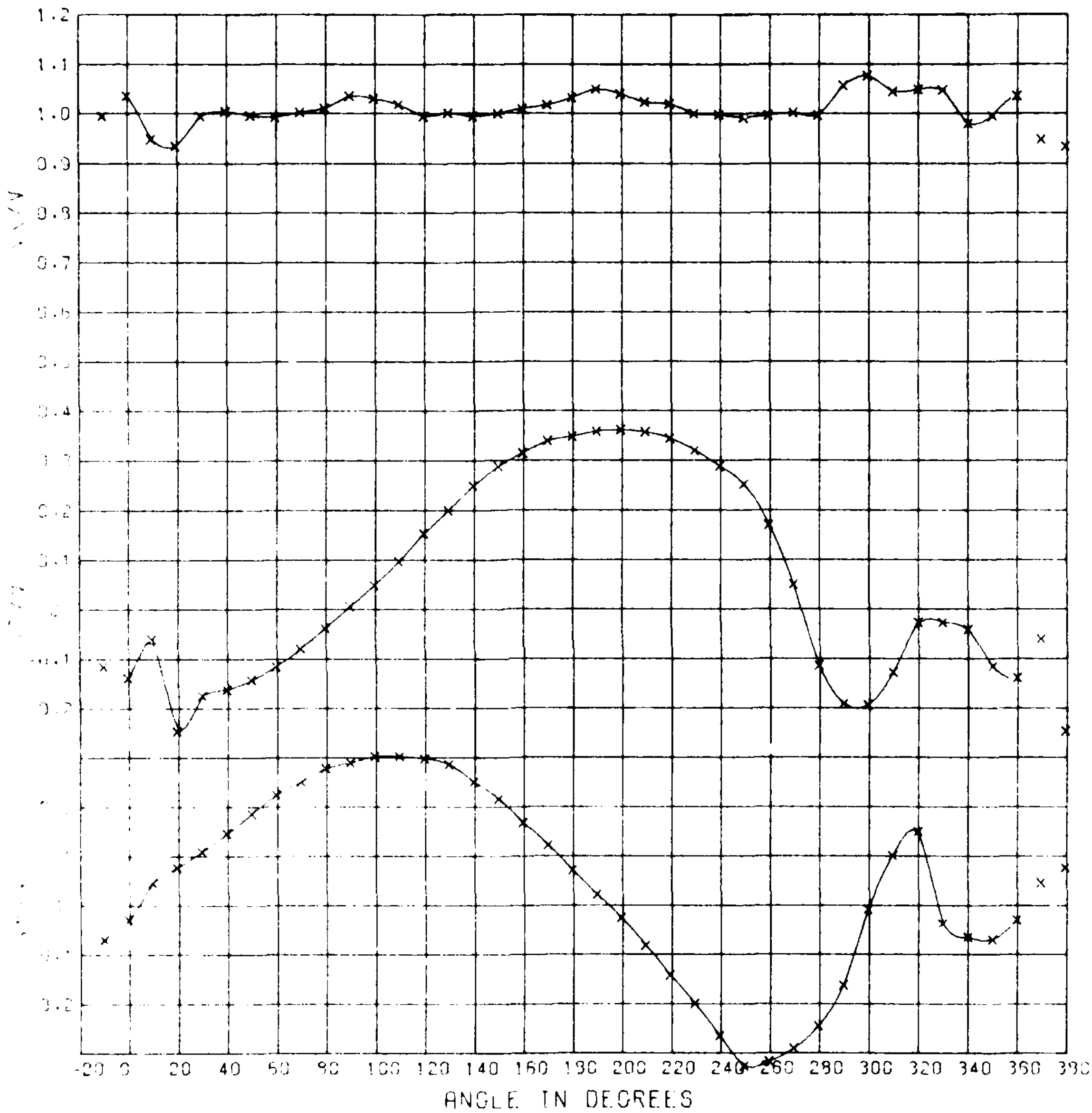


Figure 22 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.911 for Experiment 181

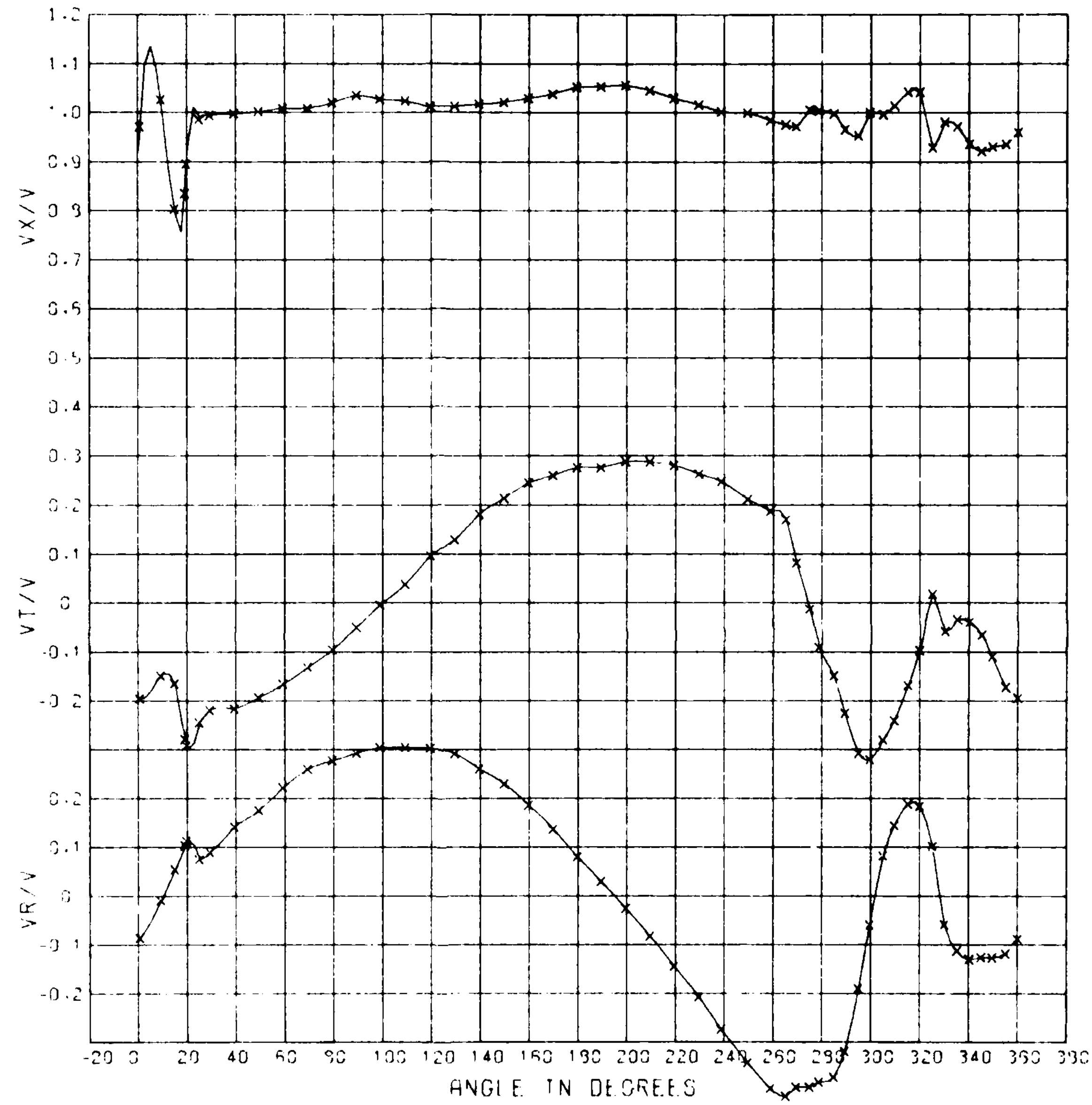


Figure 23 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 1.082 for Experiment 181

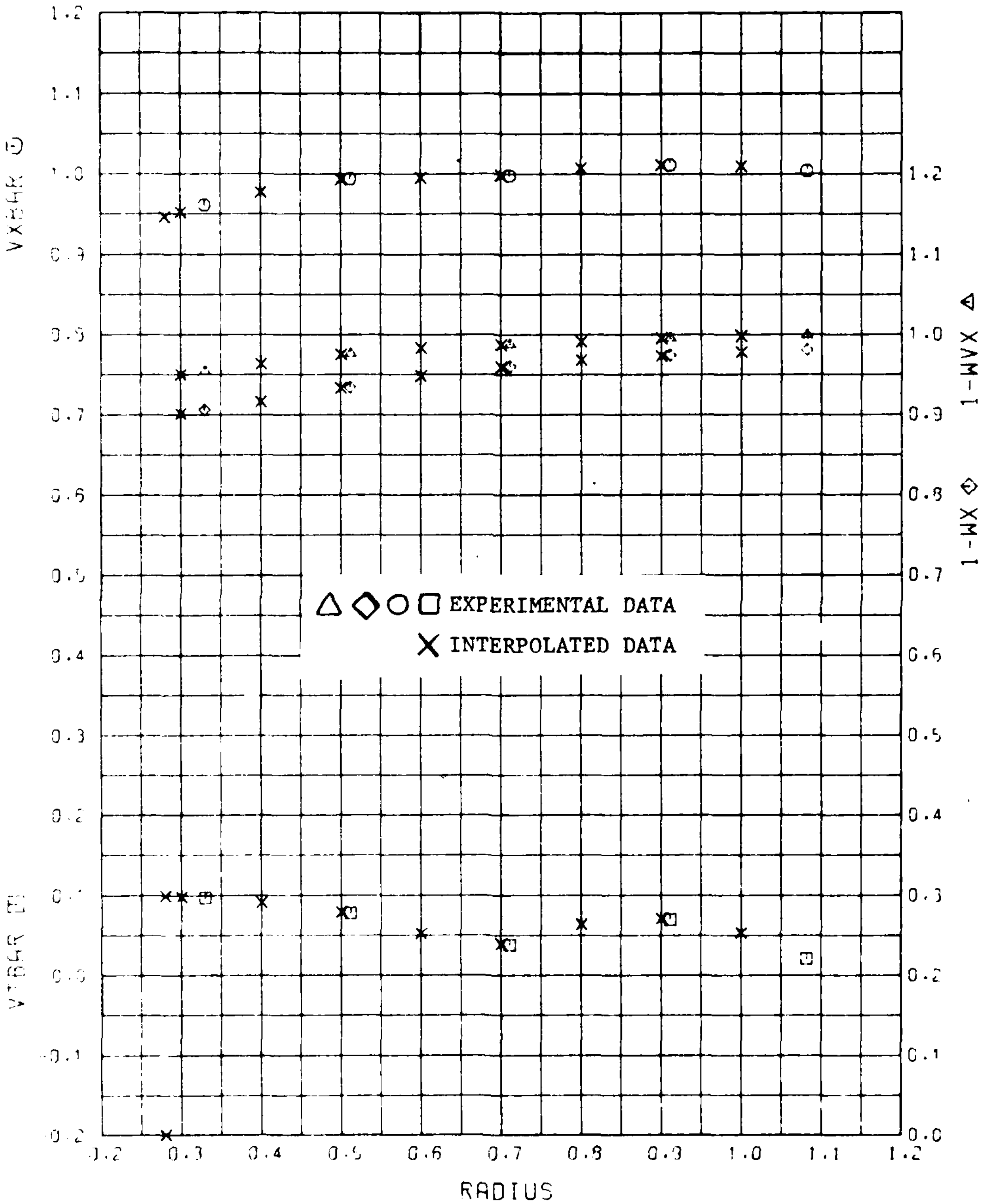


Figure 24 - Radial Distribution of the Mean Velocity Component Ratios for Experiment 181

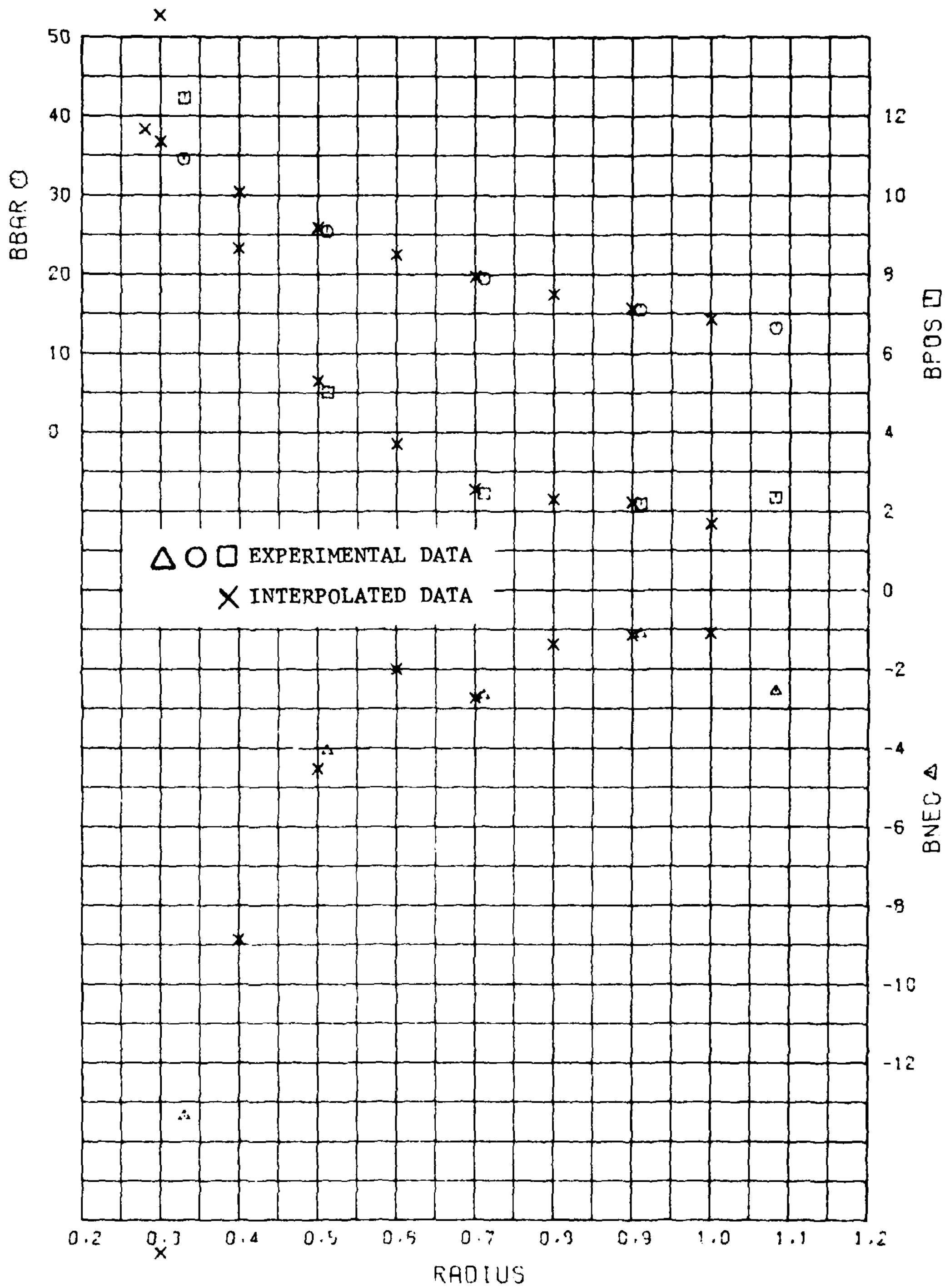


Figure 25 - Radial Distribution of the Mean Advance Angle and Advance Angle Variations for Experiment 181

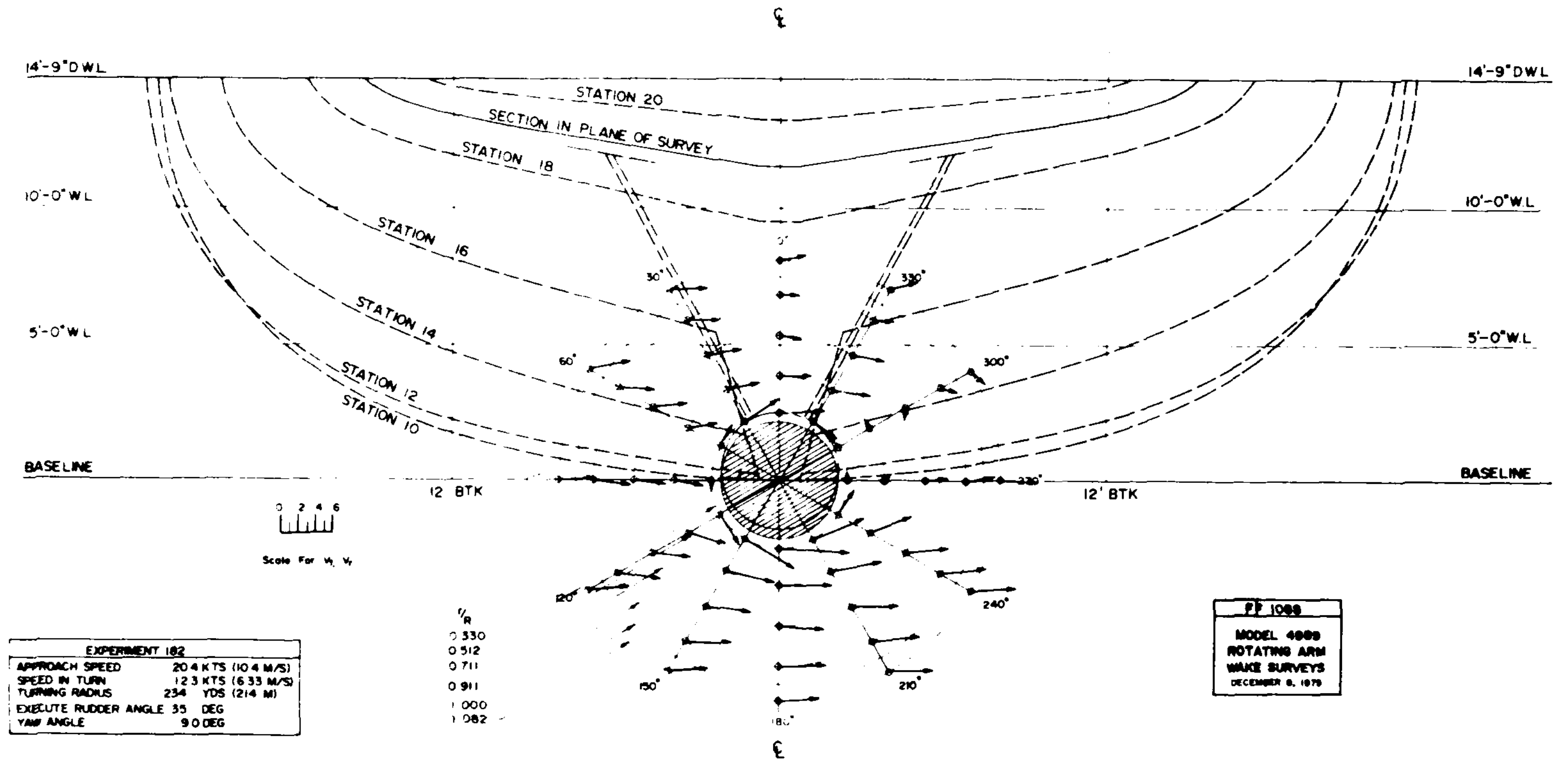


Figure 26 - Velocity Vector Diagram of the Flow In the Propeller Plane for Experiment 182

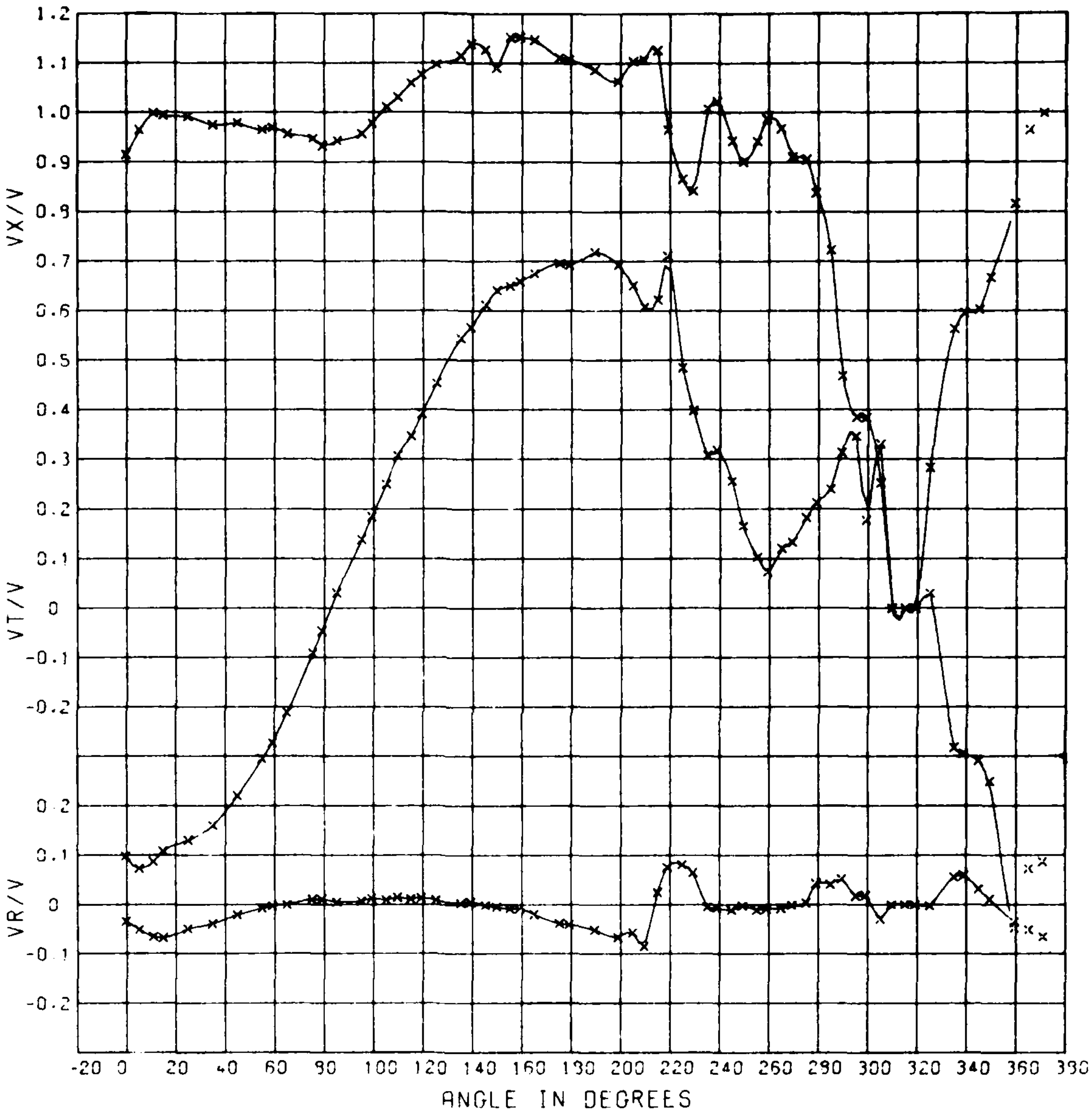


Figure 27 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratio - Radius Ratio = 0.330 for Experiment 182

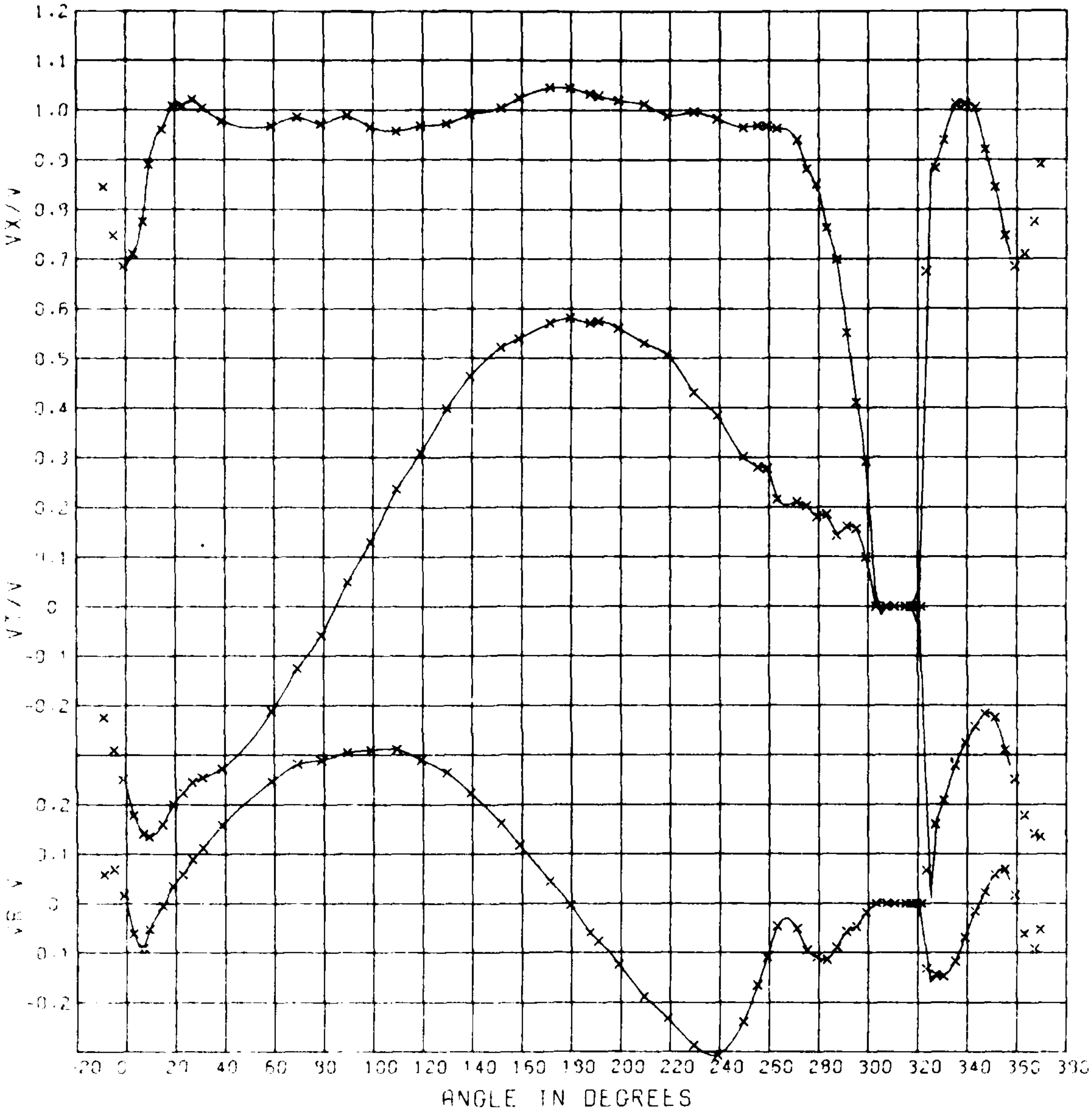


Figure 28 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.512 for Experiment 182

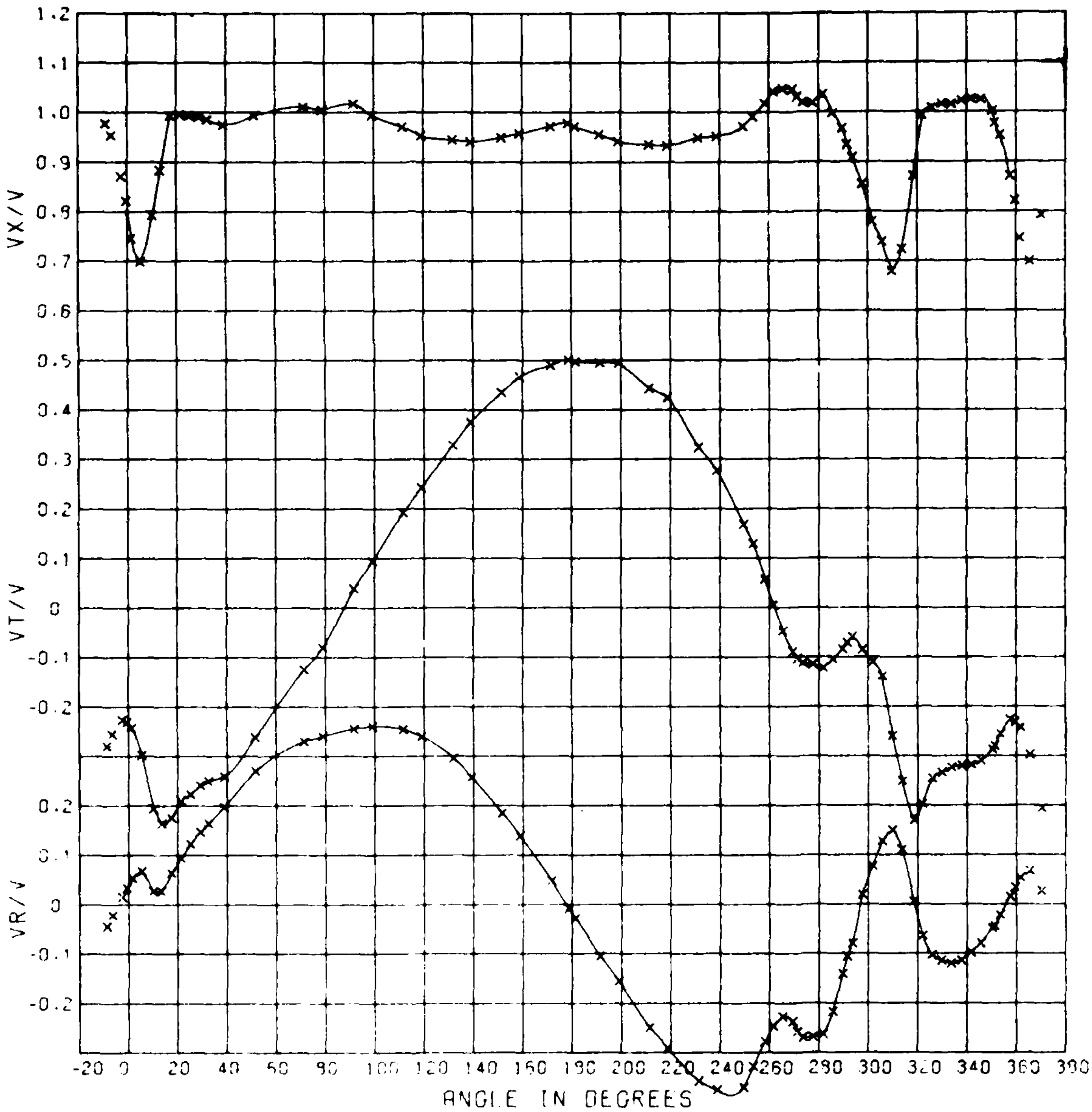


Figure 29 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.711 for Experiment 182

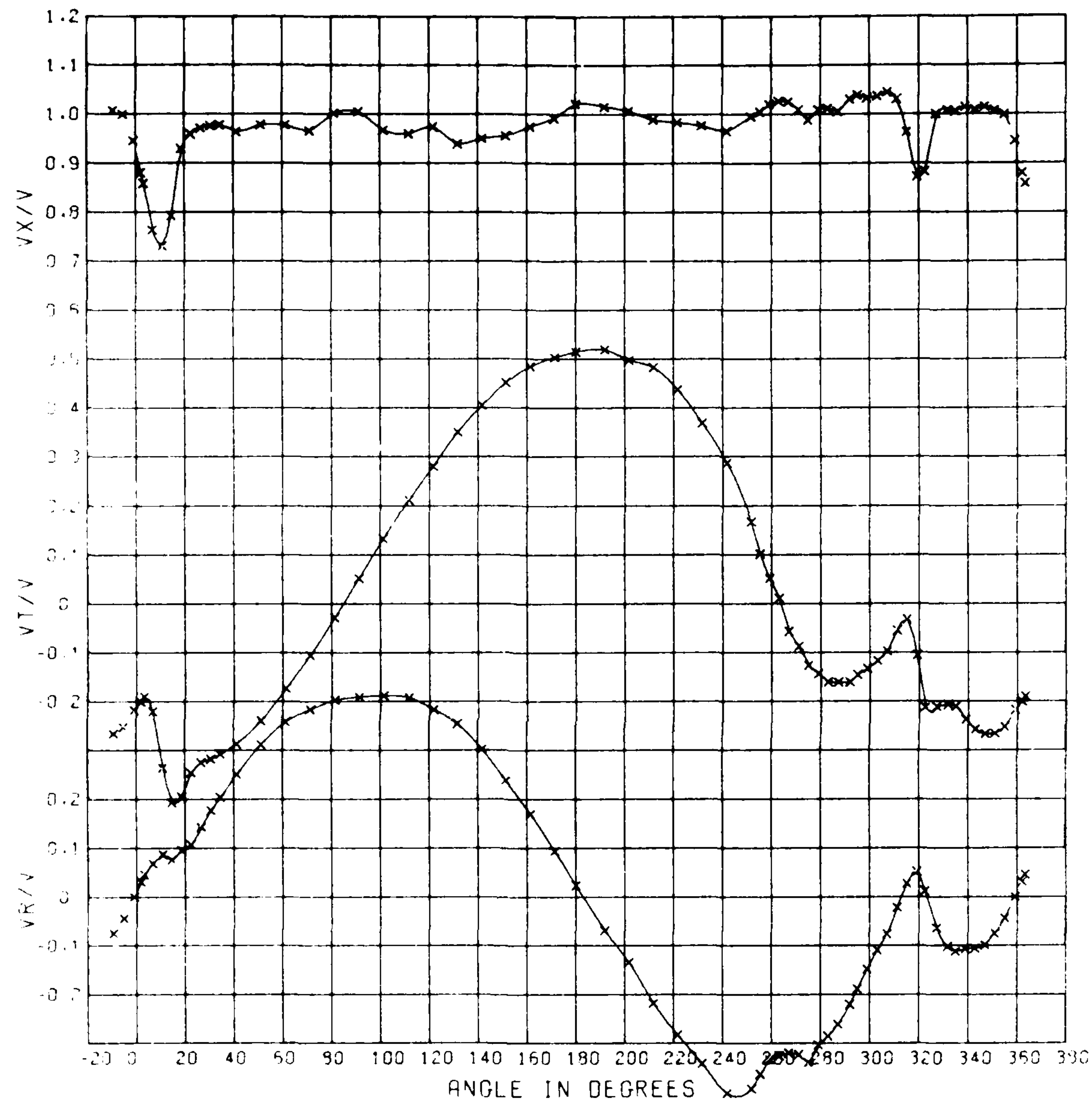


Figure 30 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.911 for Experiment 182

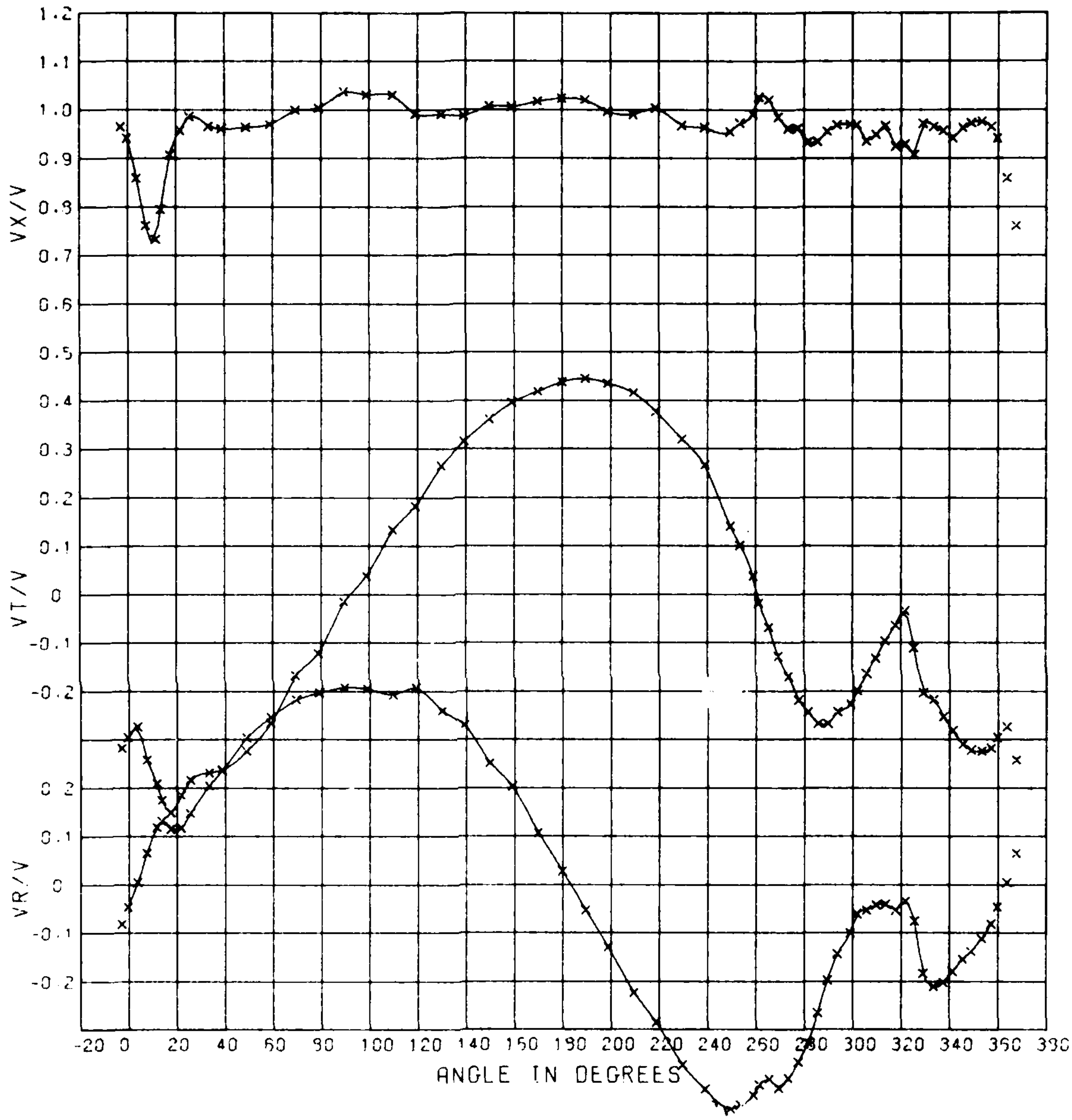


Figure 31 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 1.082 for Experiment 182

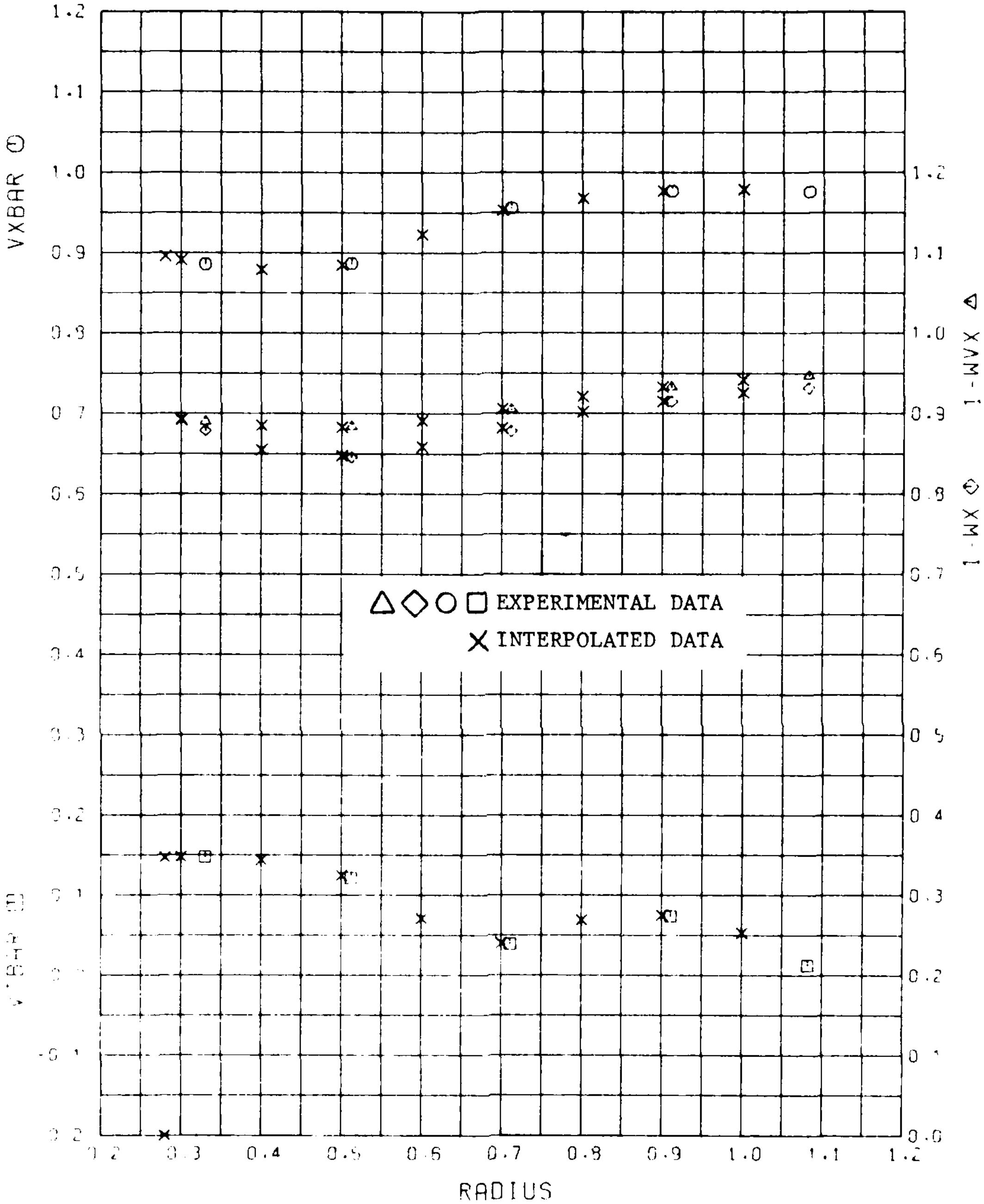


Figure 32 - Radial Distribution of the Mean Velocity Component Ratios for Experiment 182

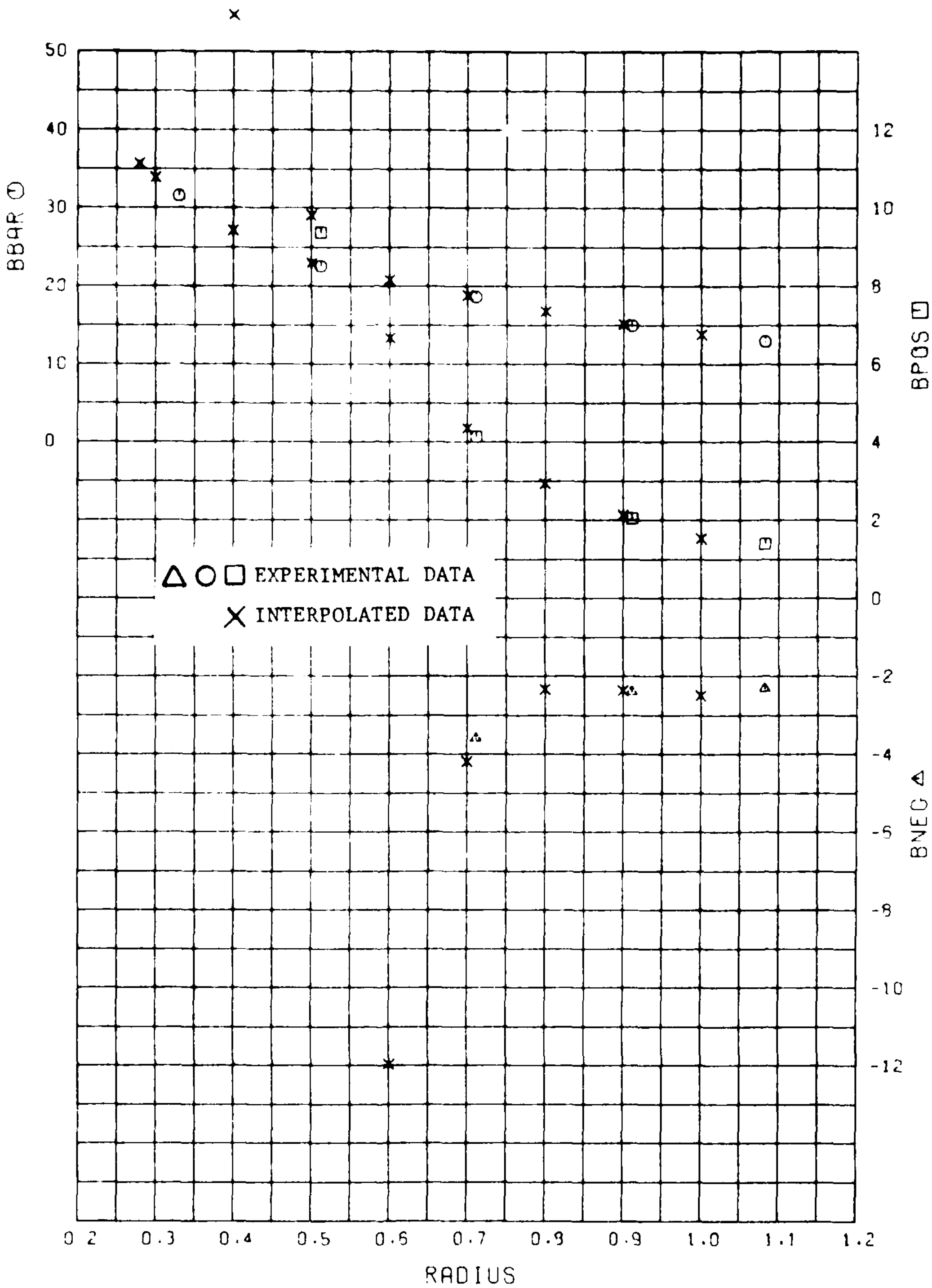


Figure 33 - Radial Distribution of the Mean Advance Angle and Advance Angle Variations for Experiment 182

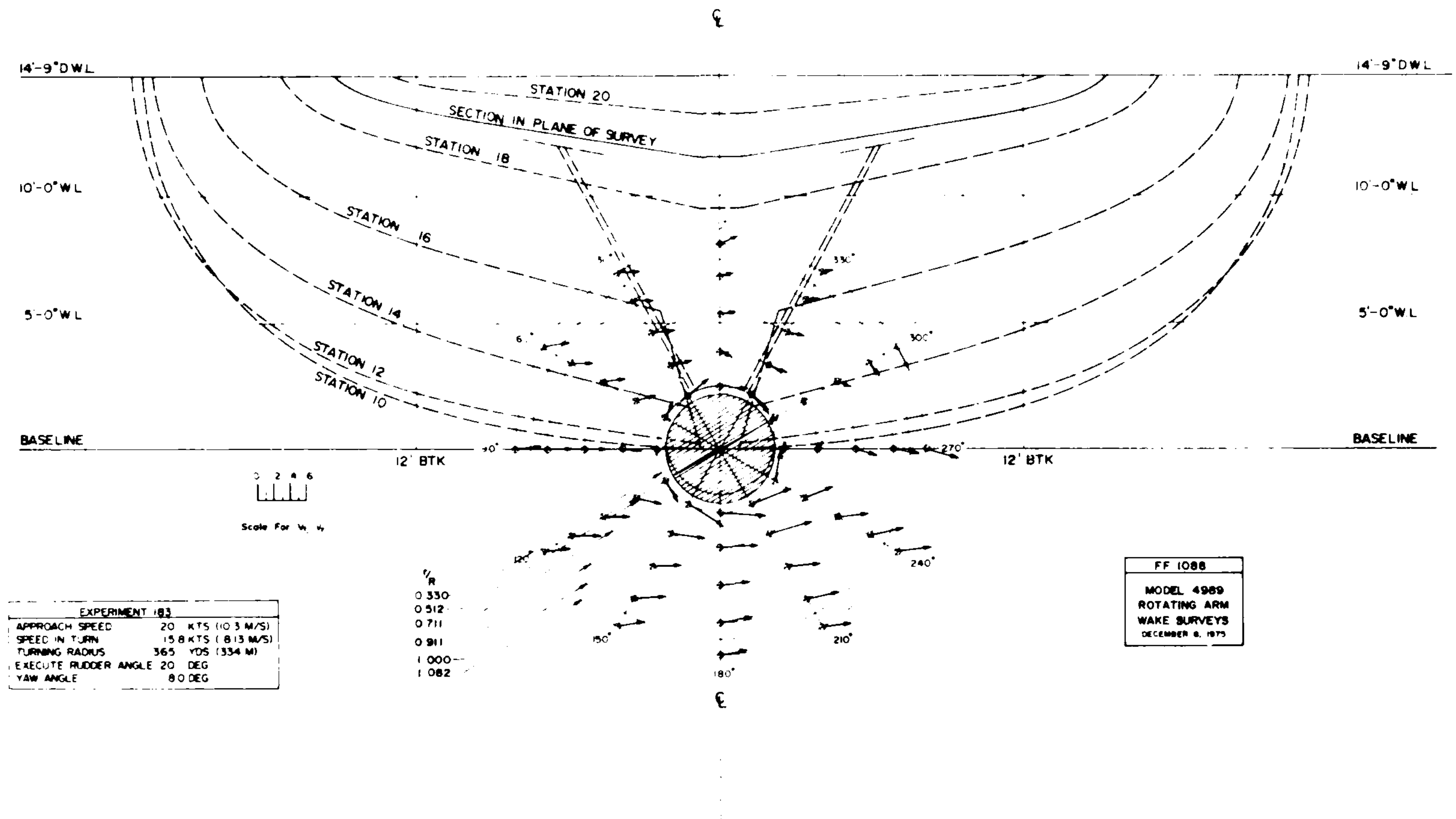


Figure 34 - Velocity Vector Diagram of the Flow In the Propeller Plane for Experiment 183

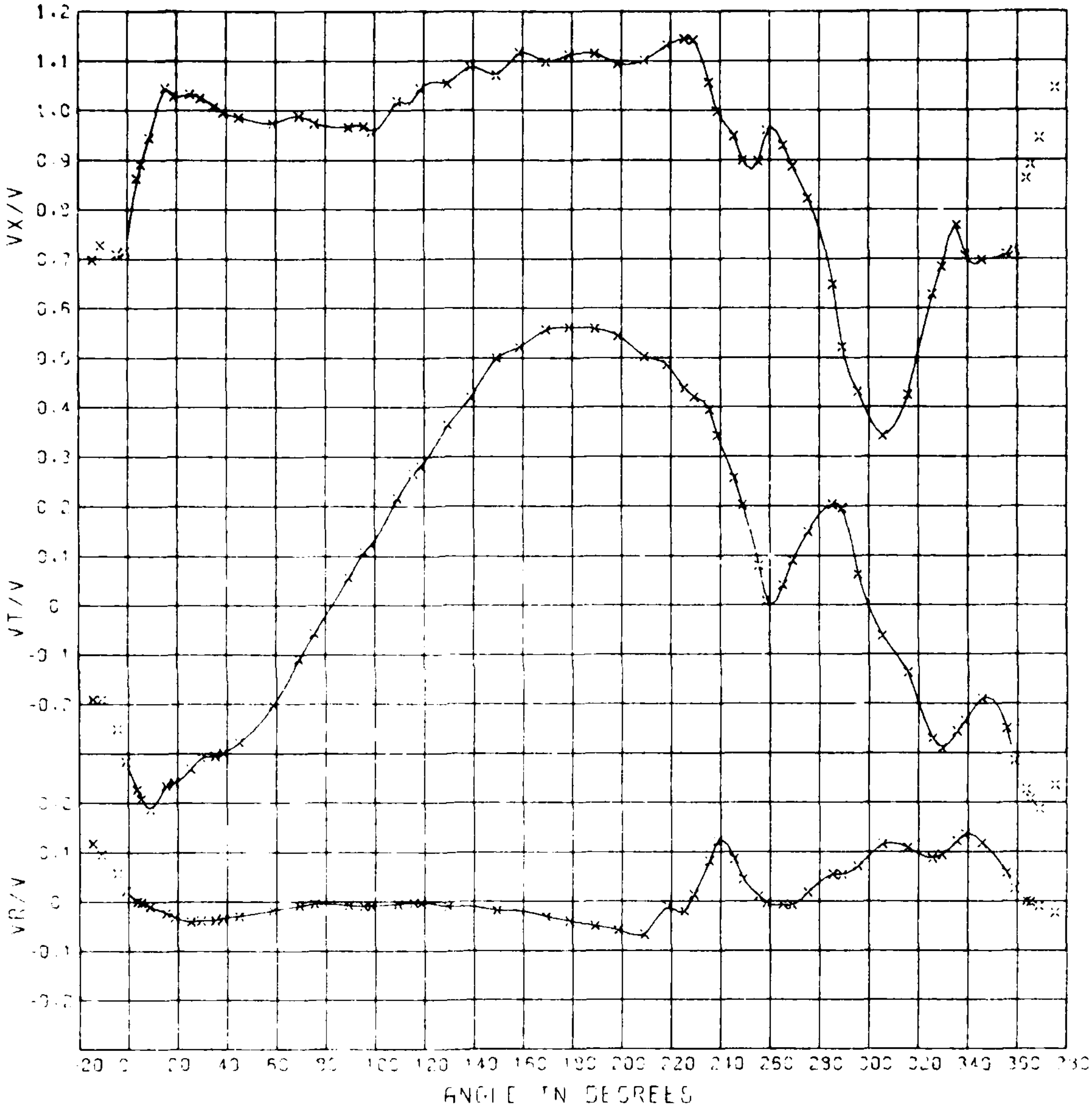


Figure 35 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio - 0.330 for Experiment 183

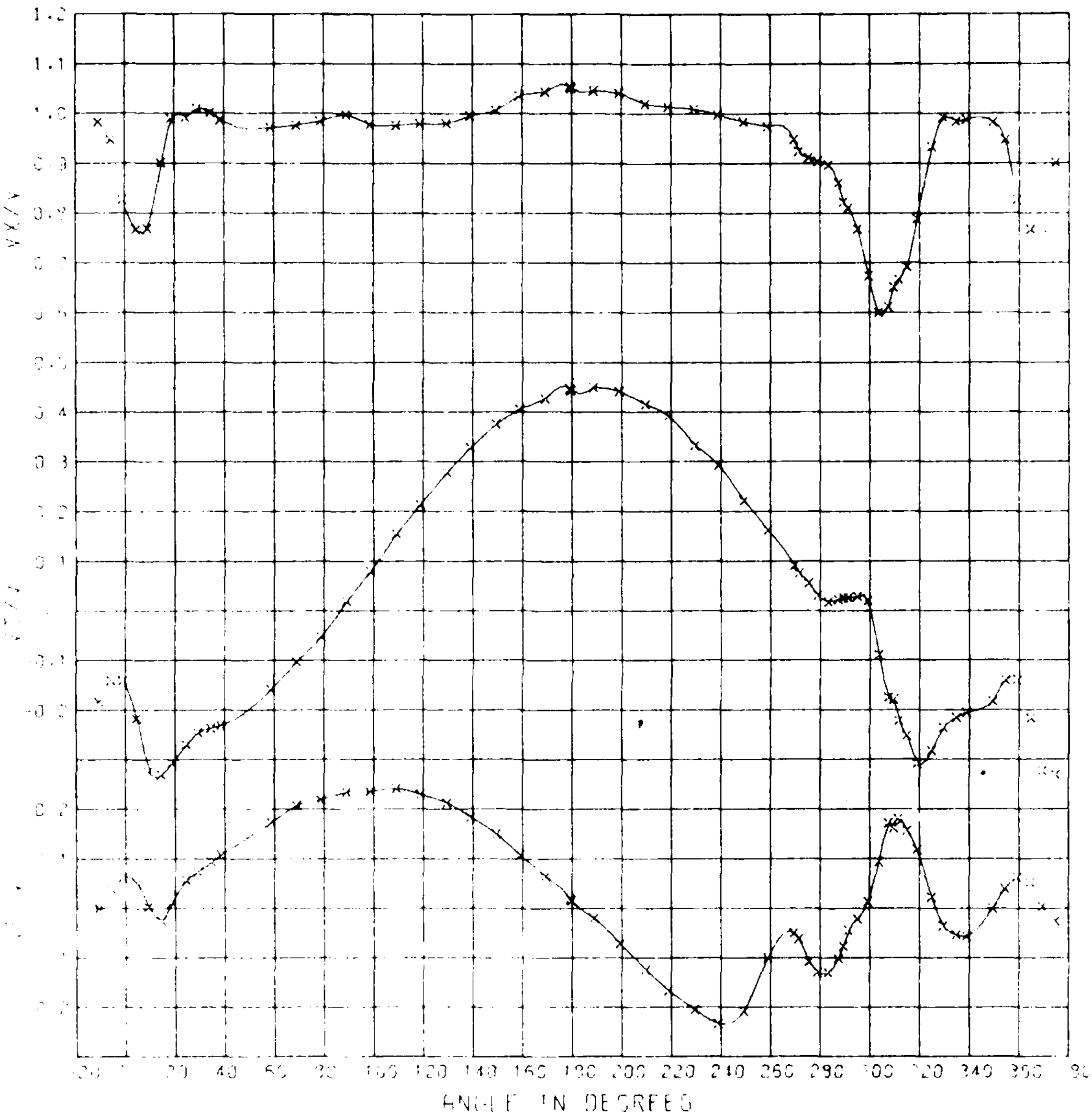


Figure 36 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.512 for Experiment 183

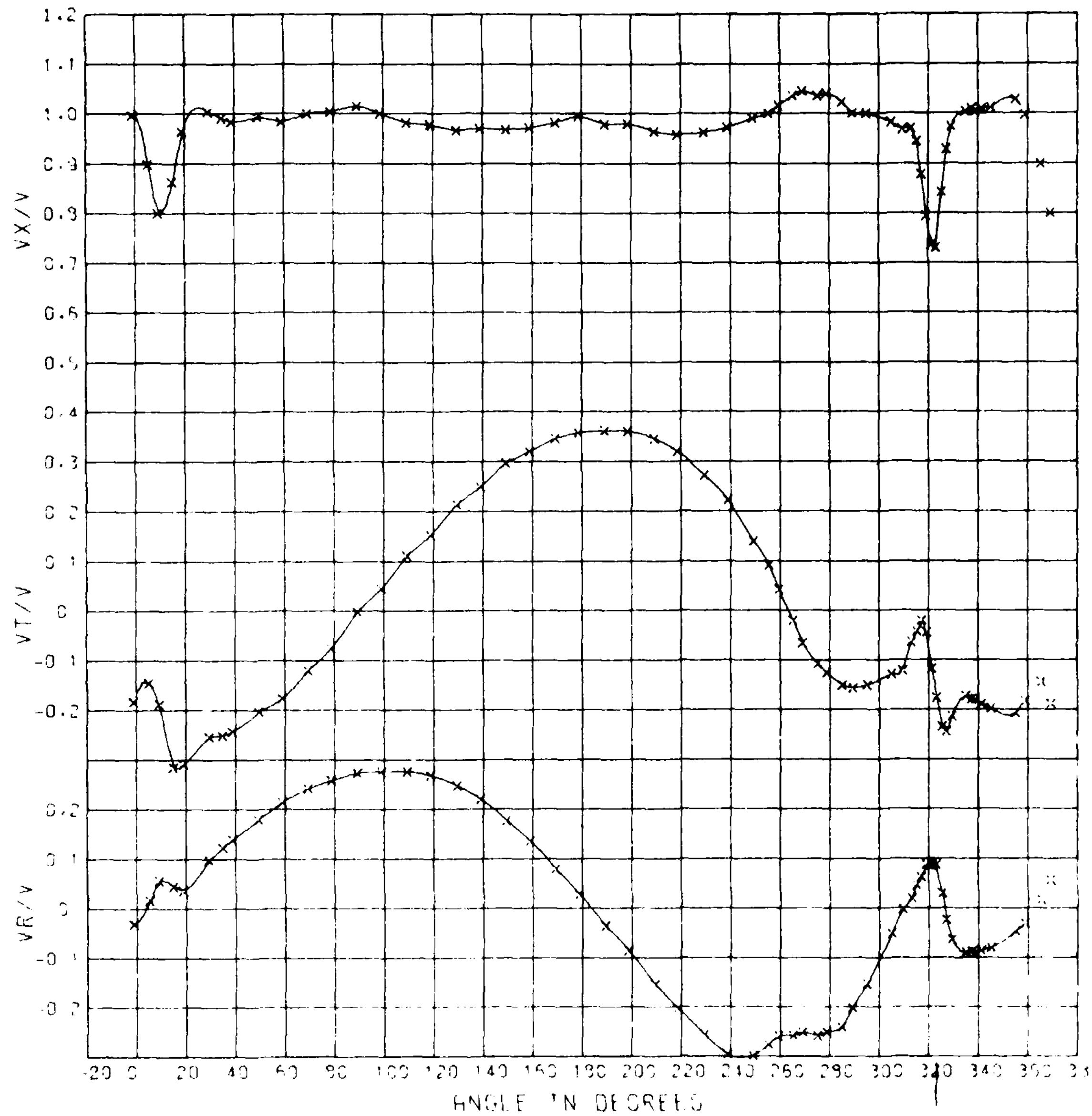


Figure 37 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.711 for Experiment 183

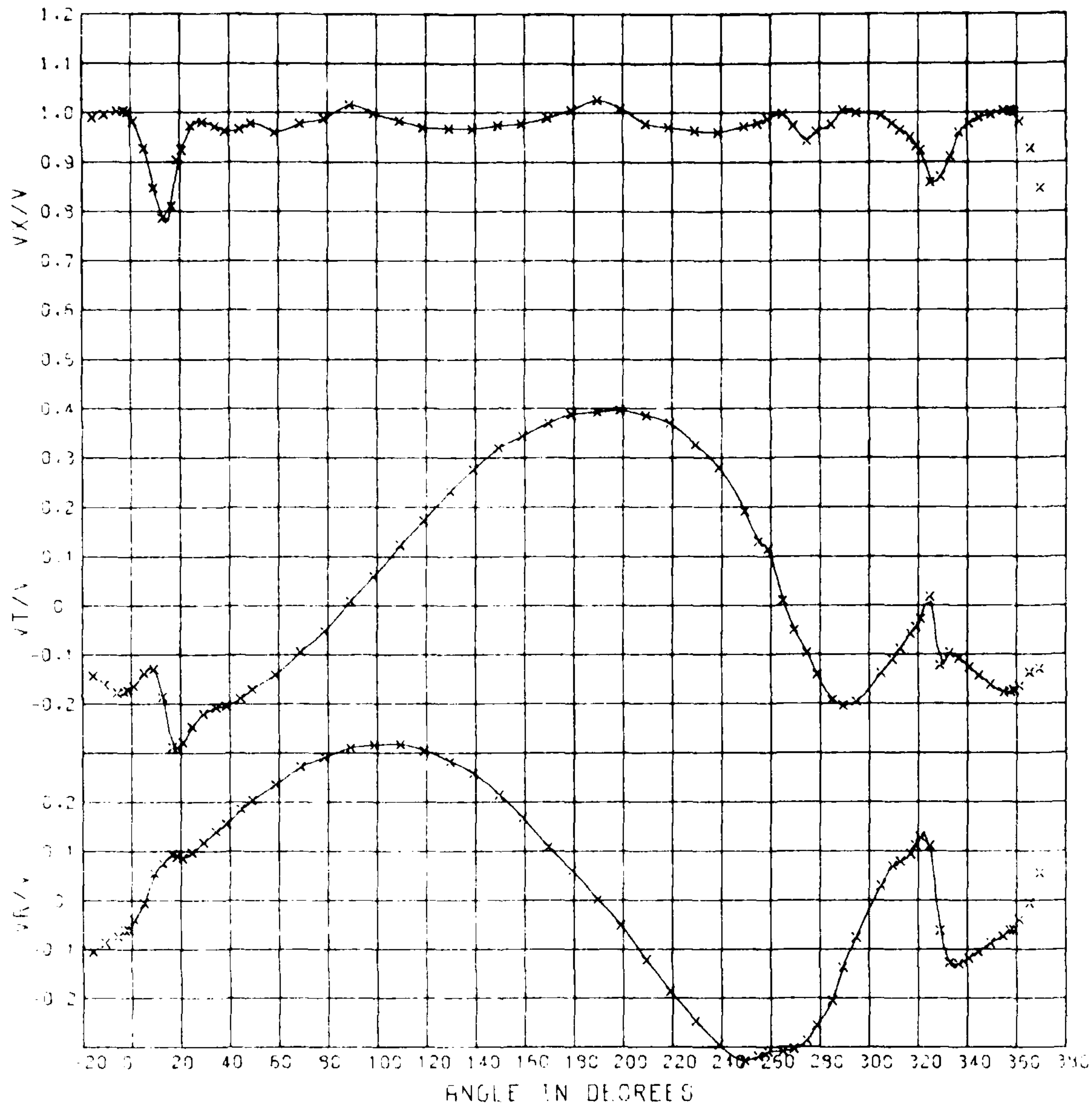


Figure 38 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.911 for Experiment 183

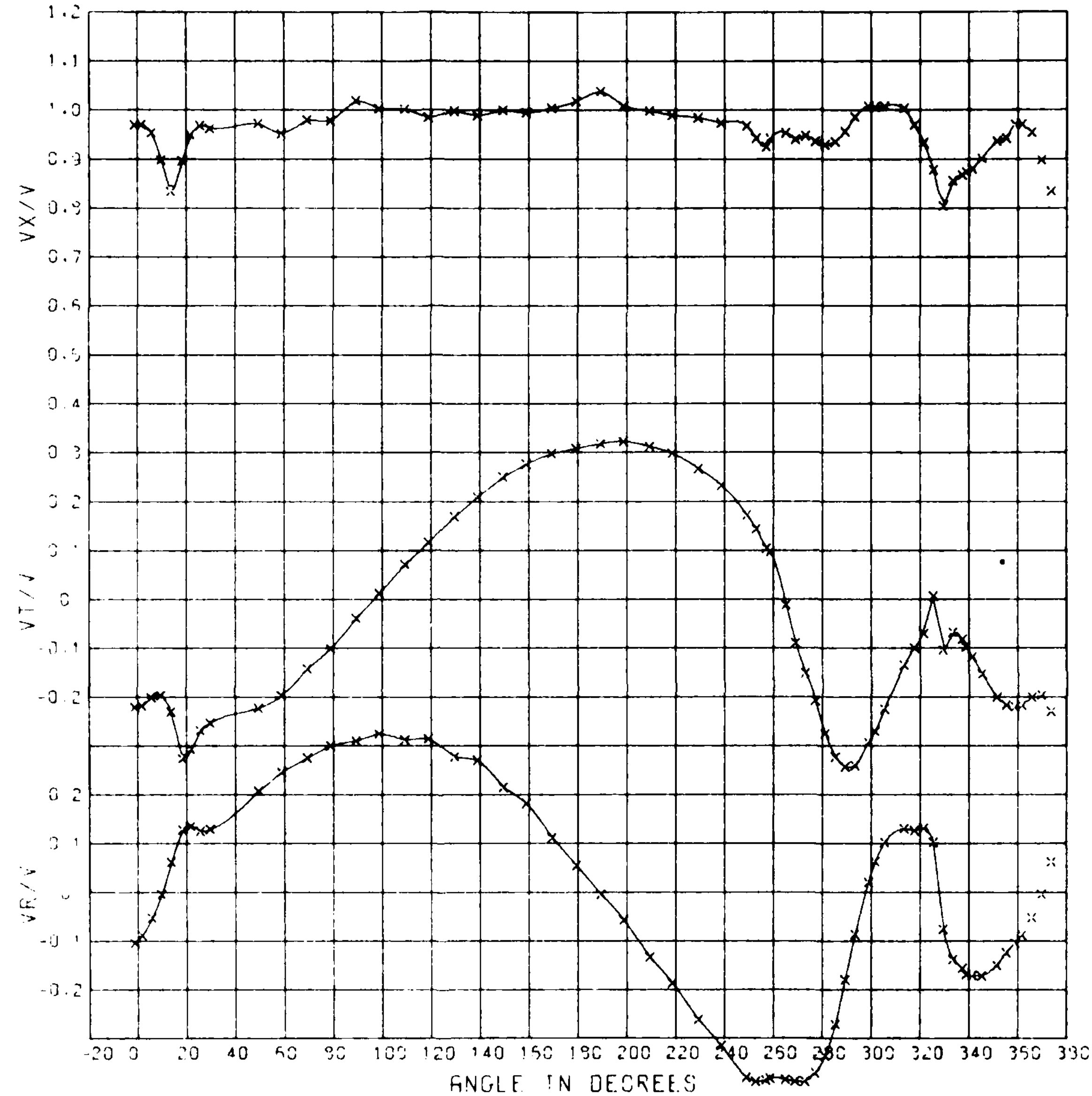


Figure 39 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 1.082 for Experiment 183

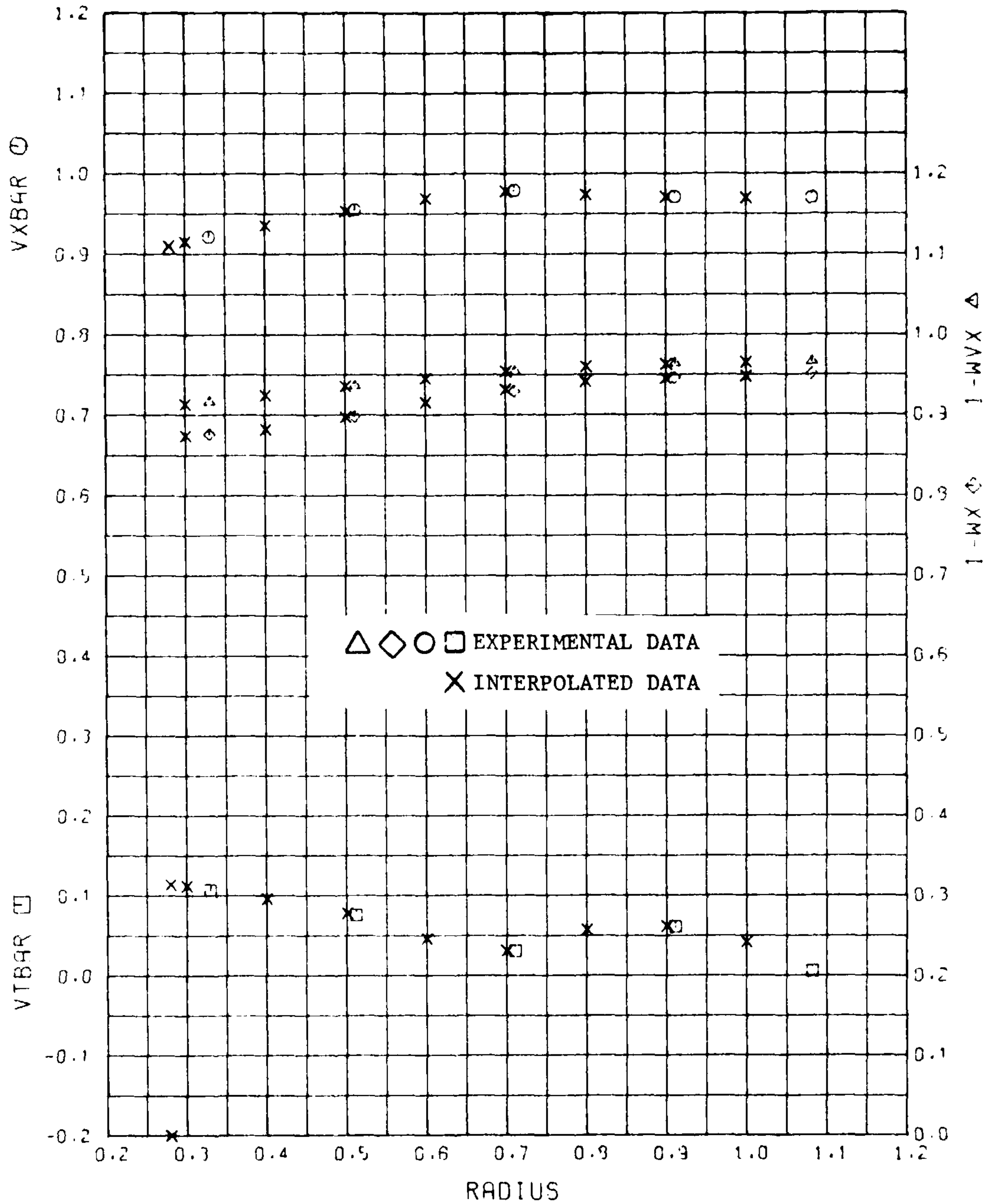


Figure 40 - Radial Distribution of the Mean Velocity Component Ratios for Experiment 183

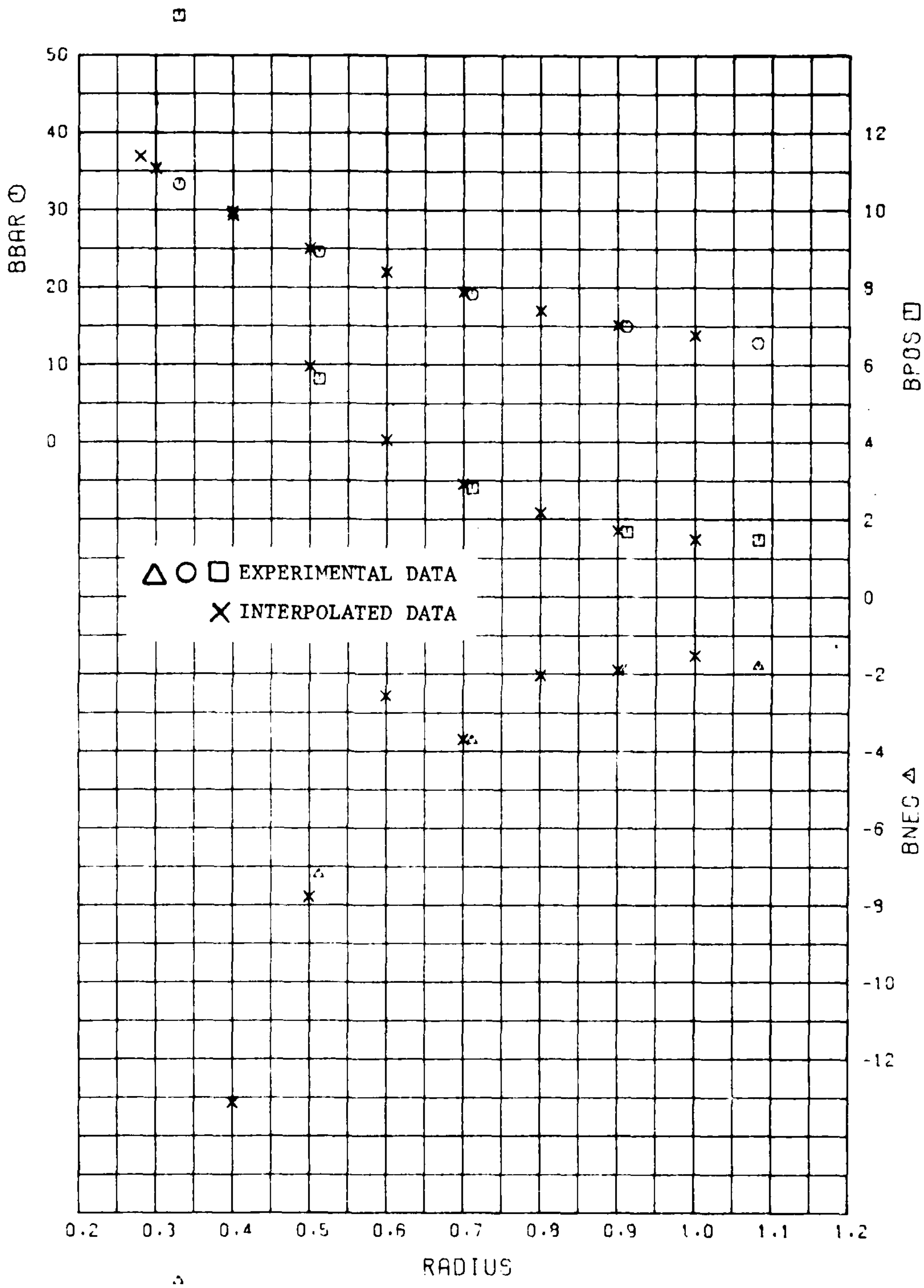


Figure 41 - Radial Distribution for the Mean Advance Angle and Advance Angle Variations for Experiment 183

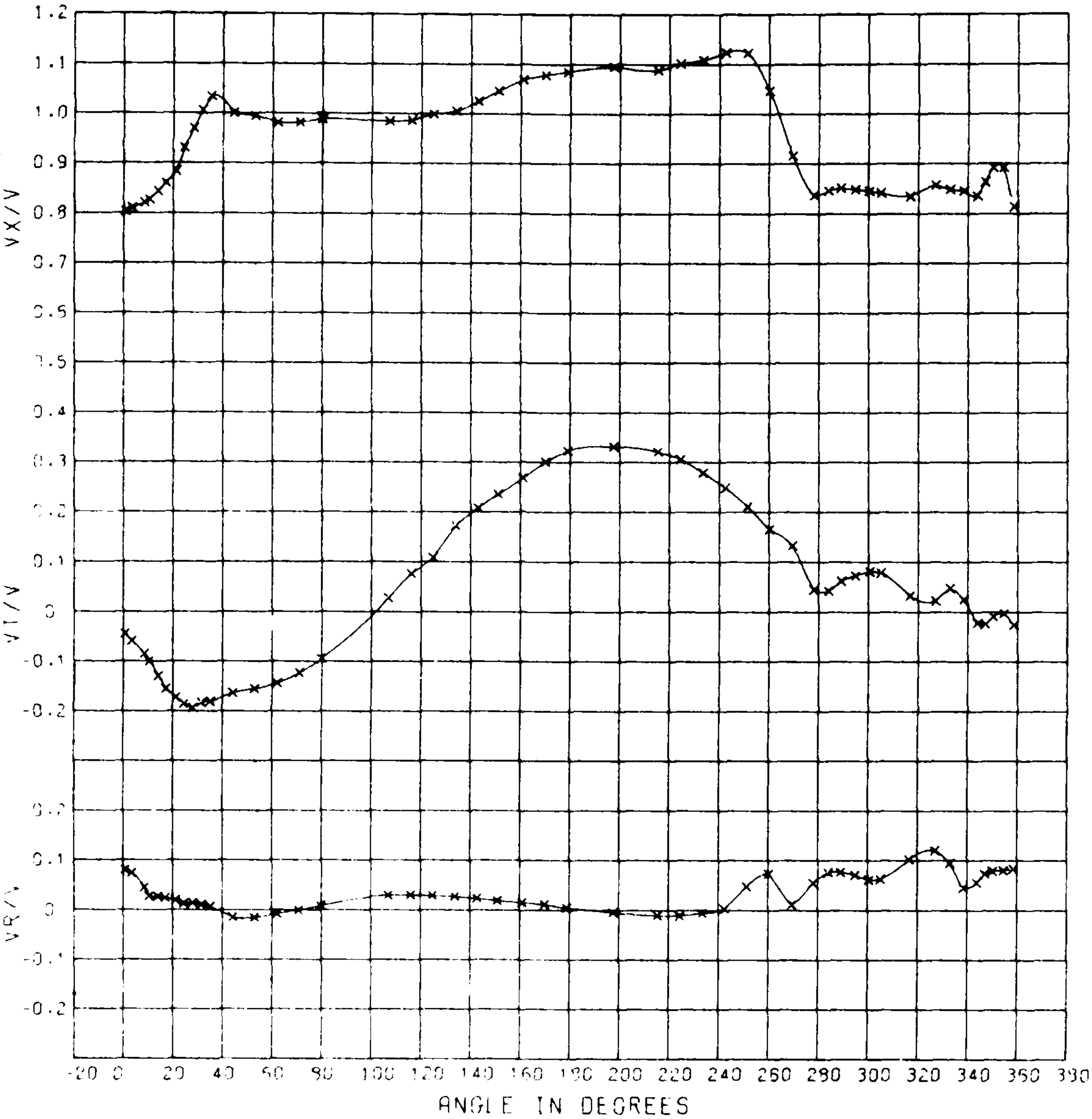


Figure 42 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.330 for Experiment 184

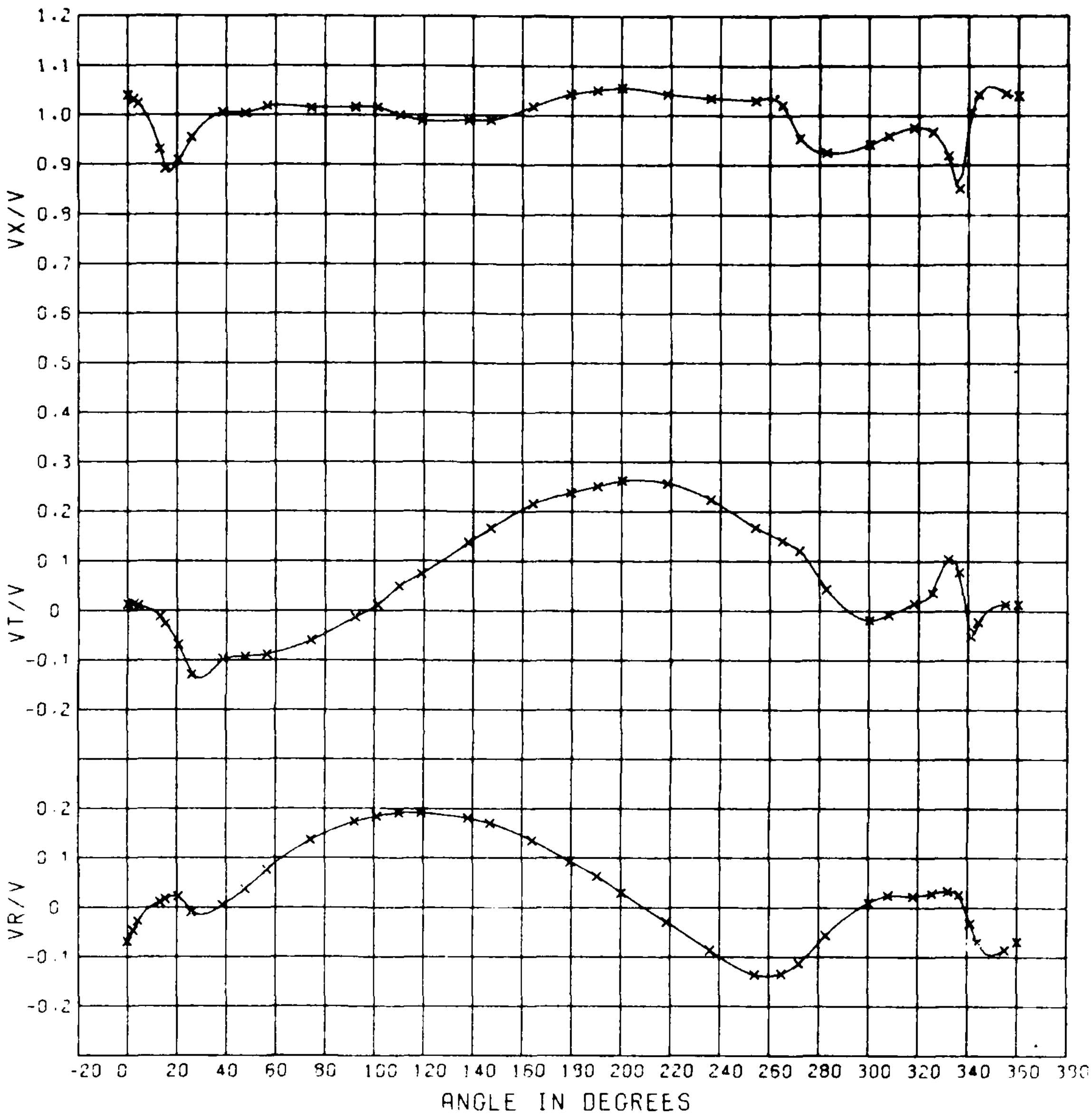


Figure 43 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.512 for Experiment 184

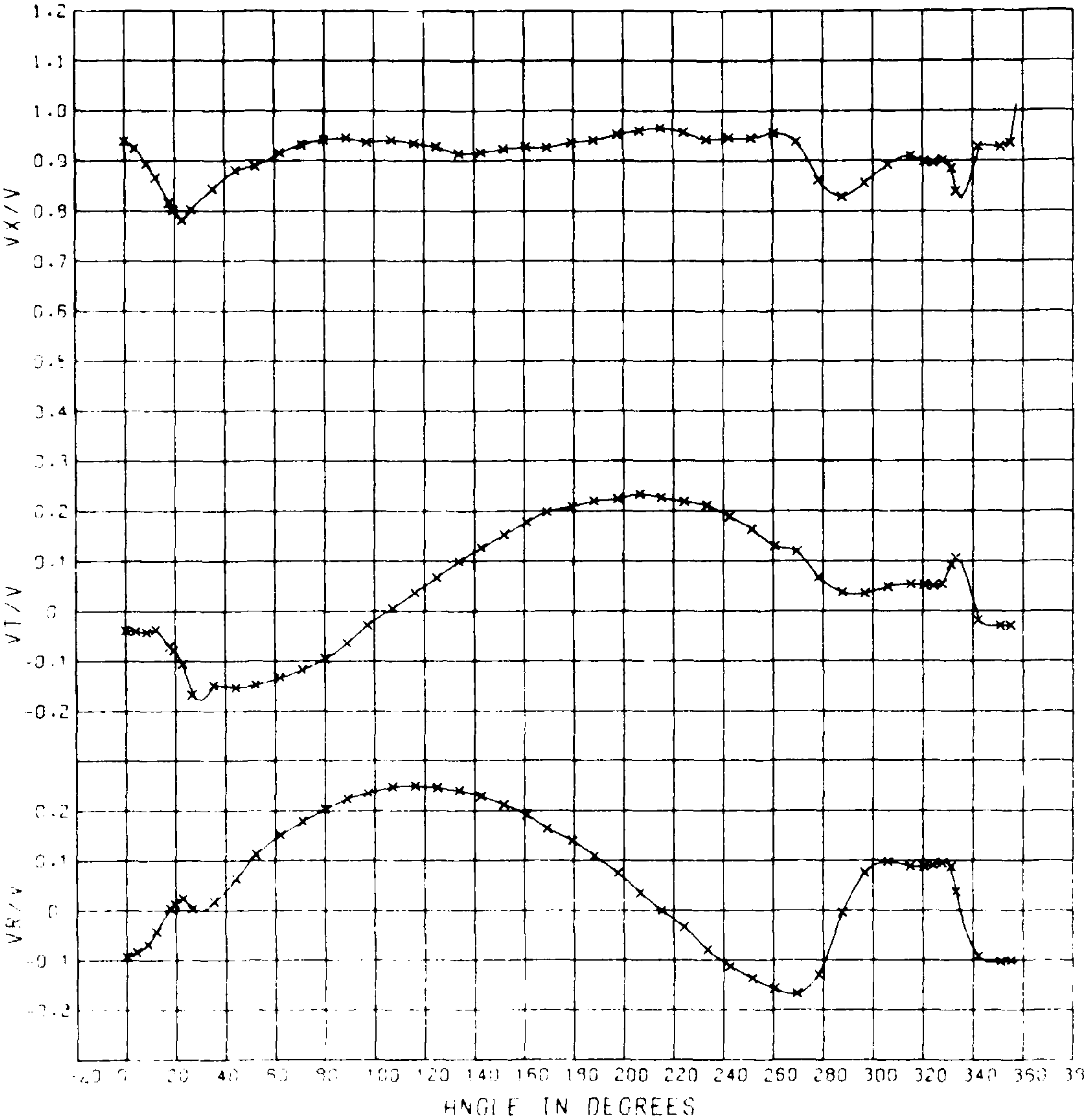


Figure 44 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.711 for Experiment 184

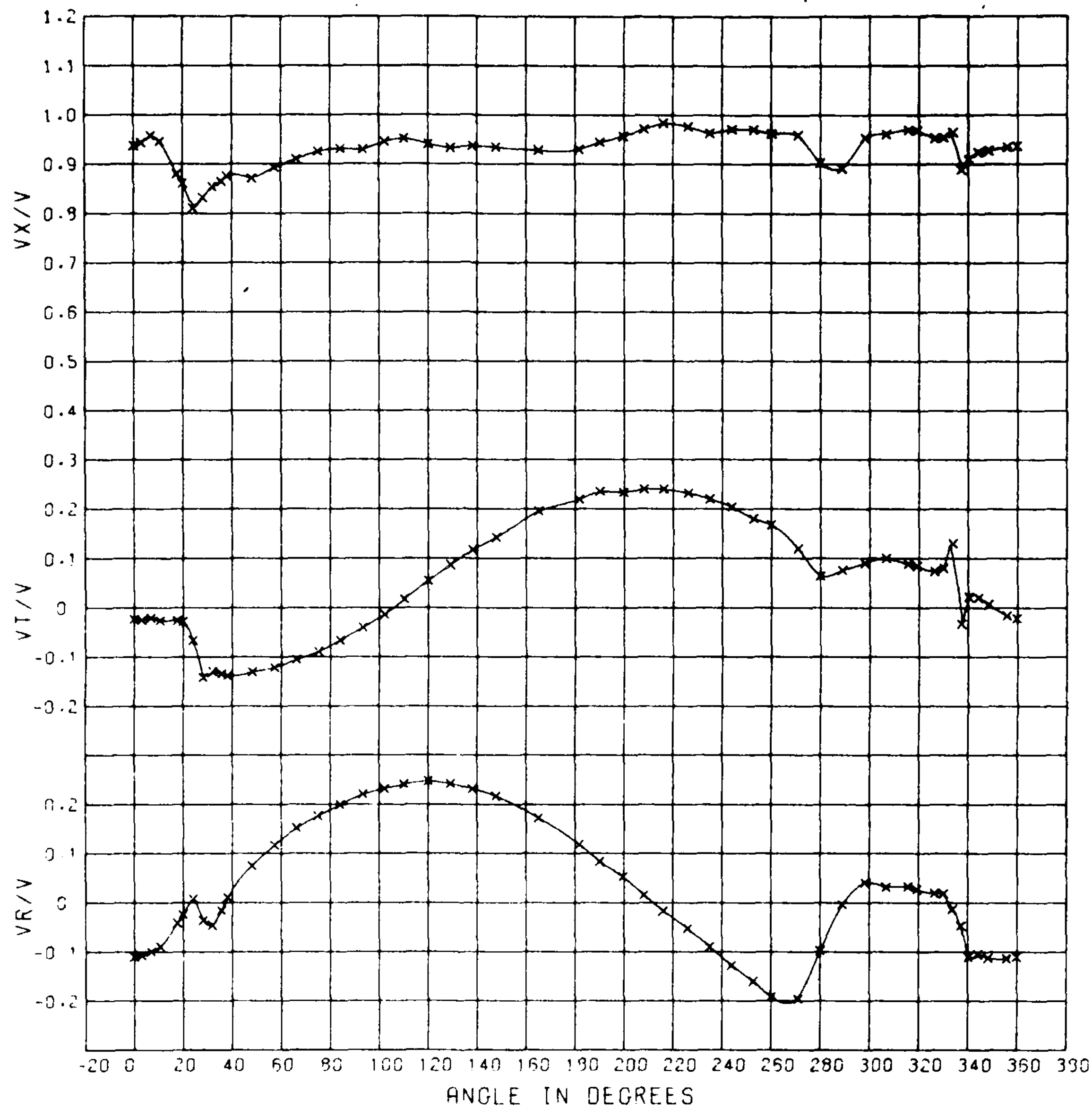


Figure 45 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.910 for Experiment 184

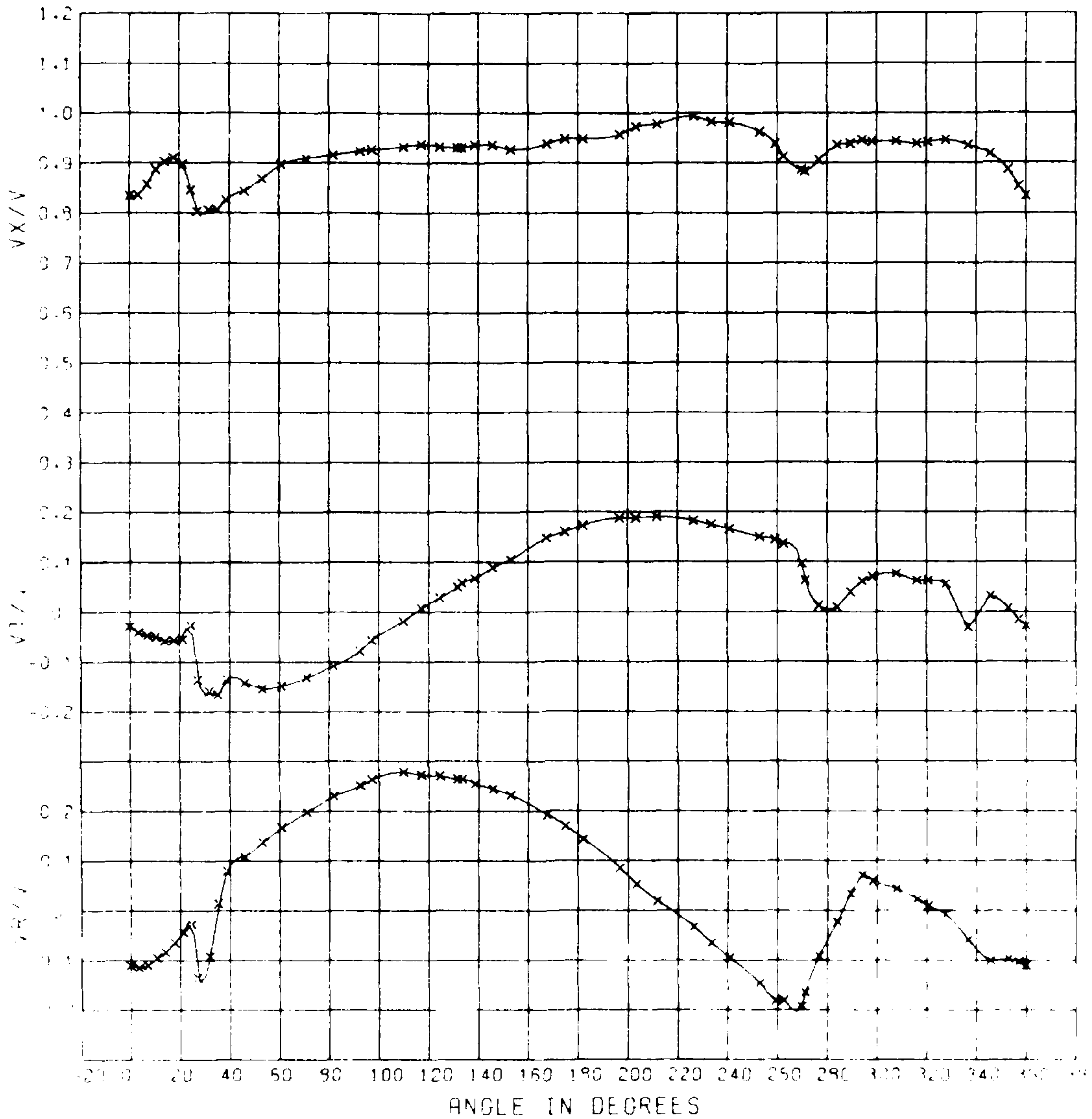


Figure 46 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 1.082 for Experiment 184

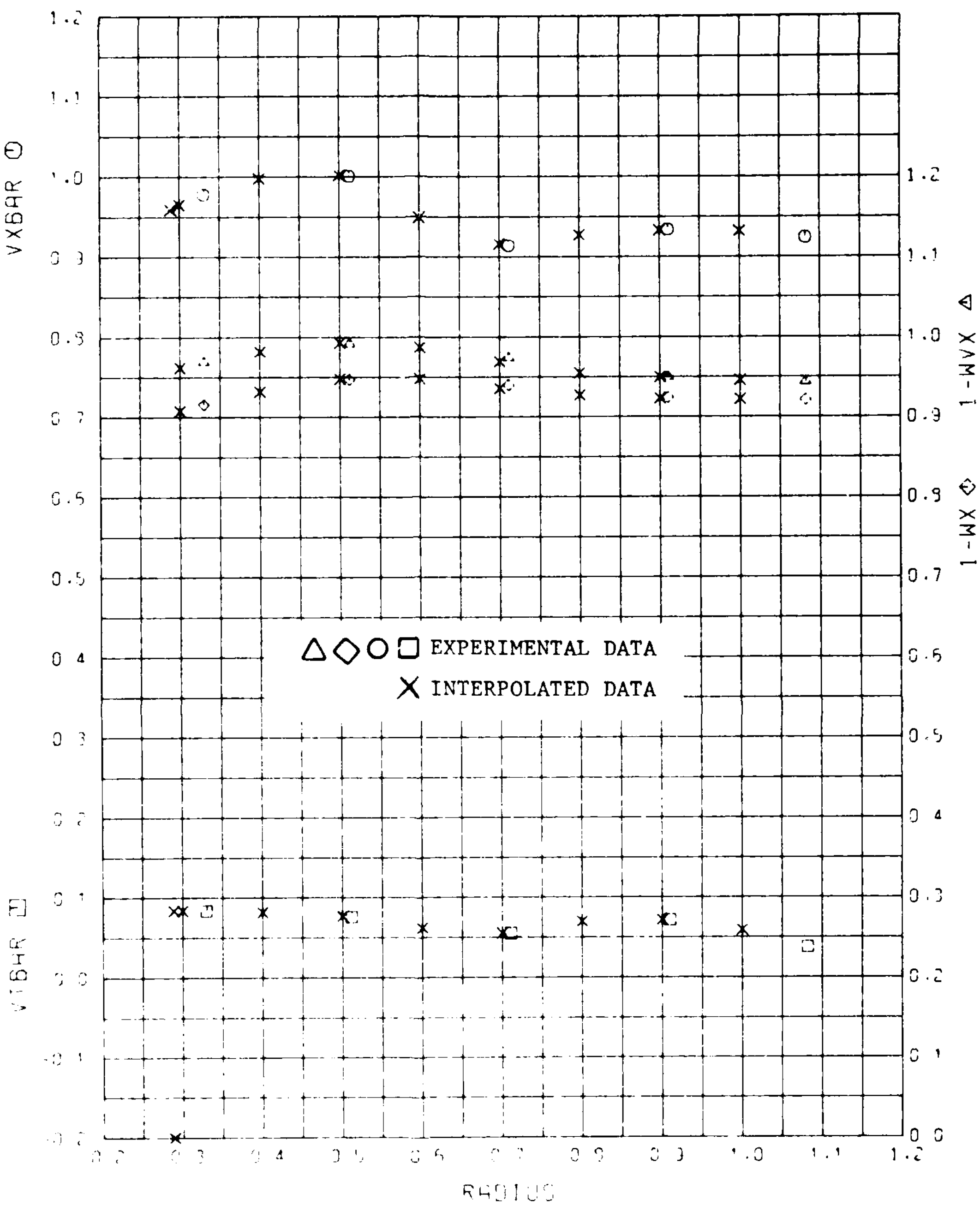


Figure 47 - Radial Distribution of the Mean Velocity Component Ratios for Experiment 184

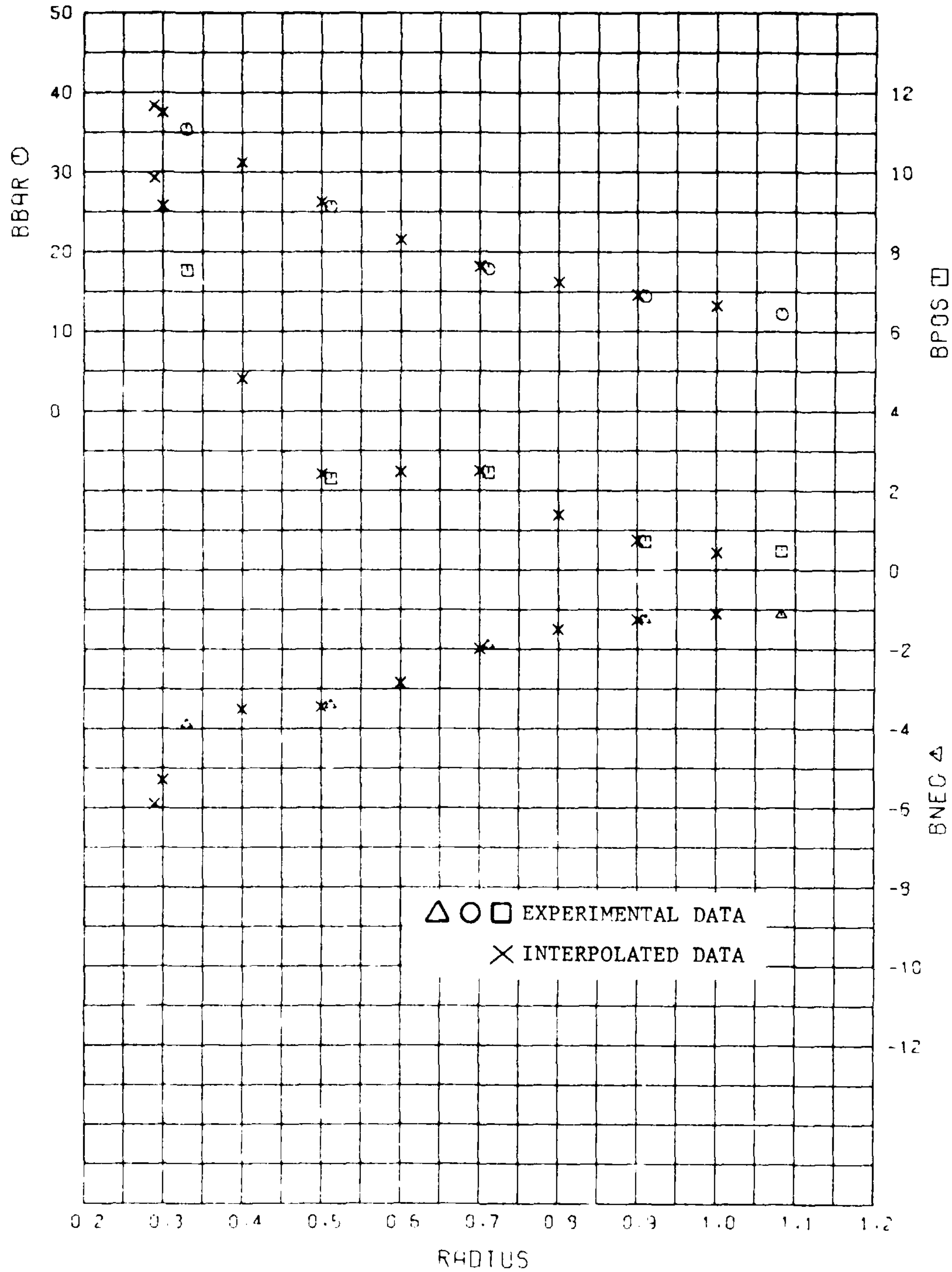


Figure 48 - Radial Distribution of the Mean Advance Angle and Advance Angle Variations for Experiment 184

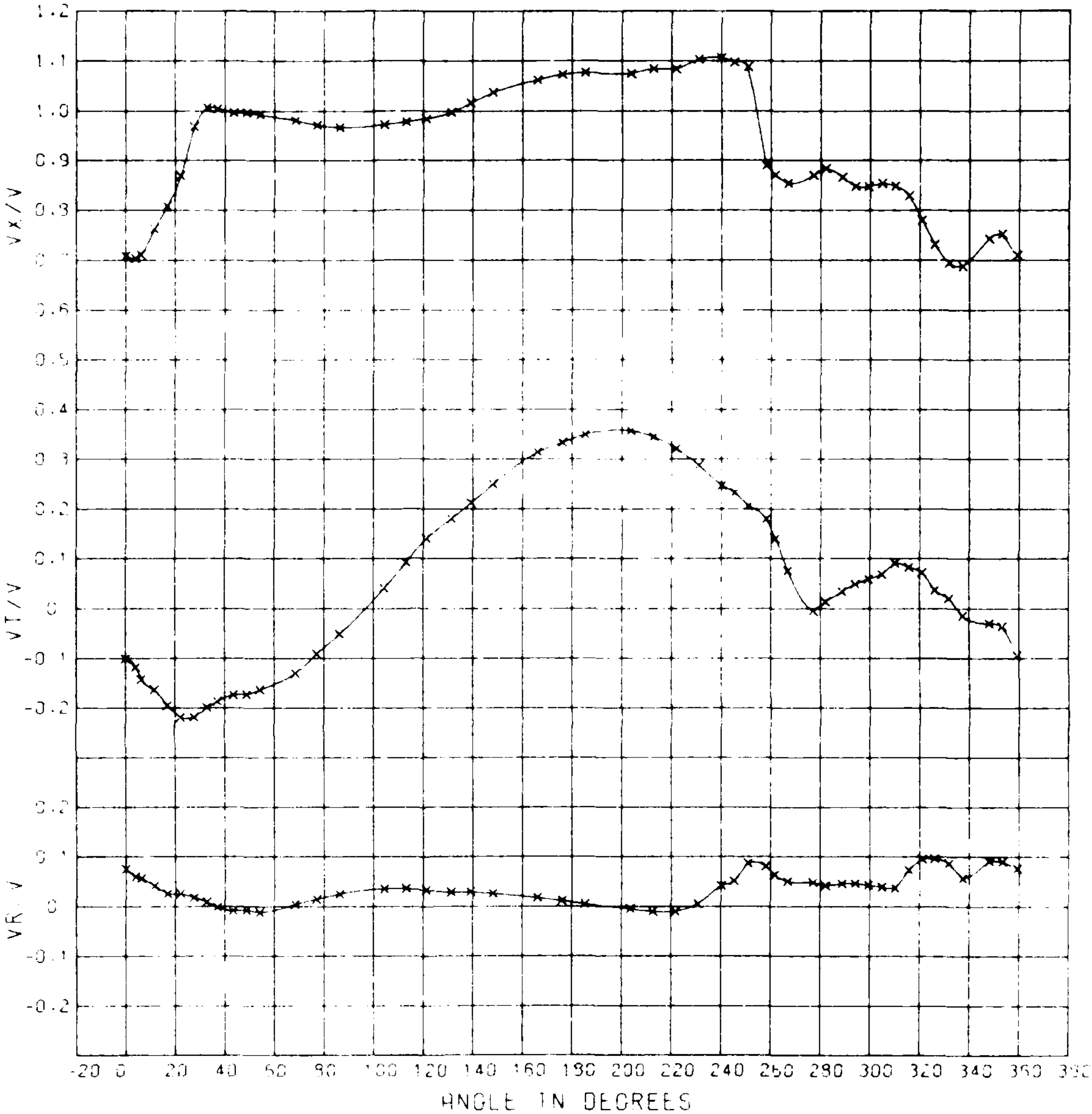


Figure 49 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.330 for Experiment 185

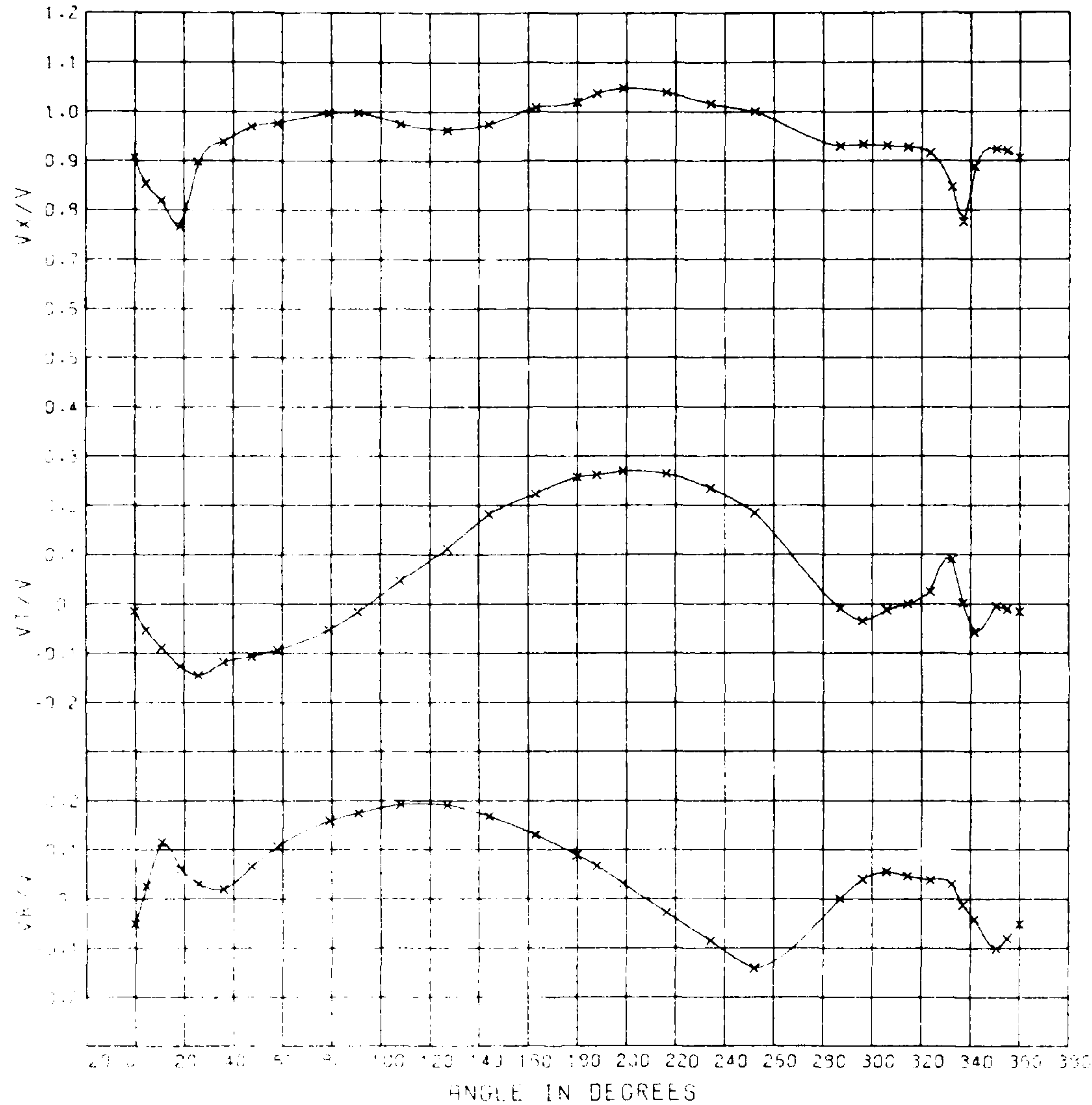


Figure 50 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.512 for Experiment 185

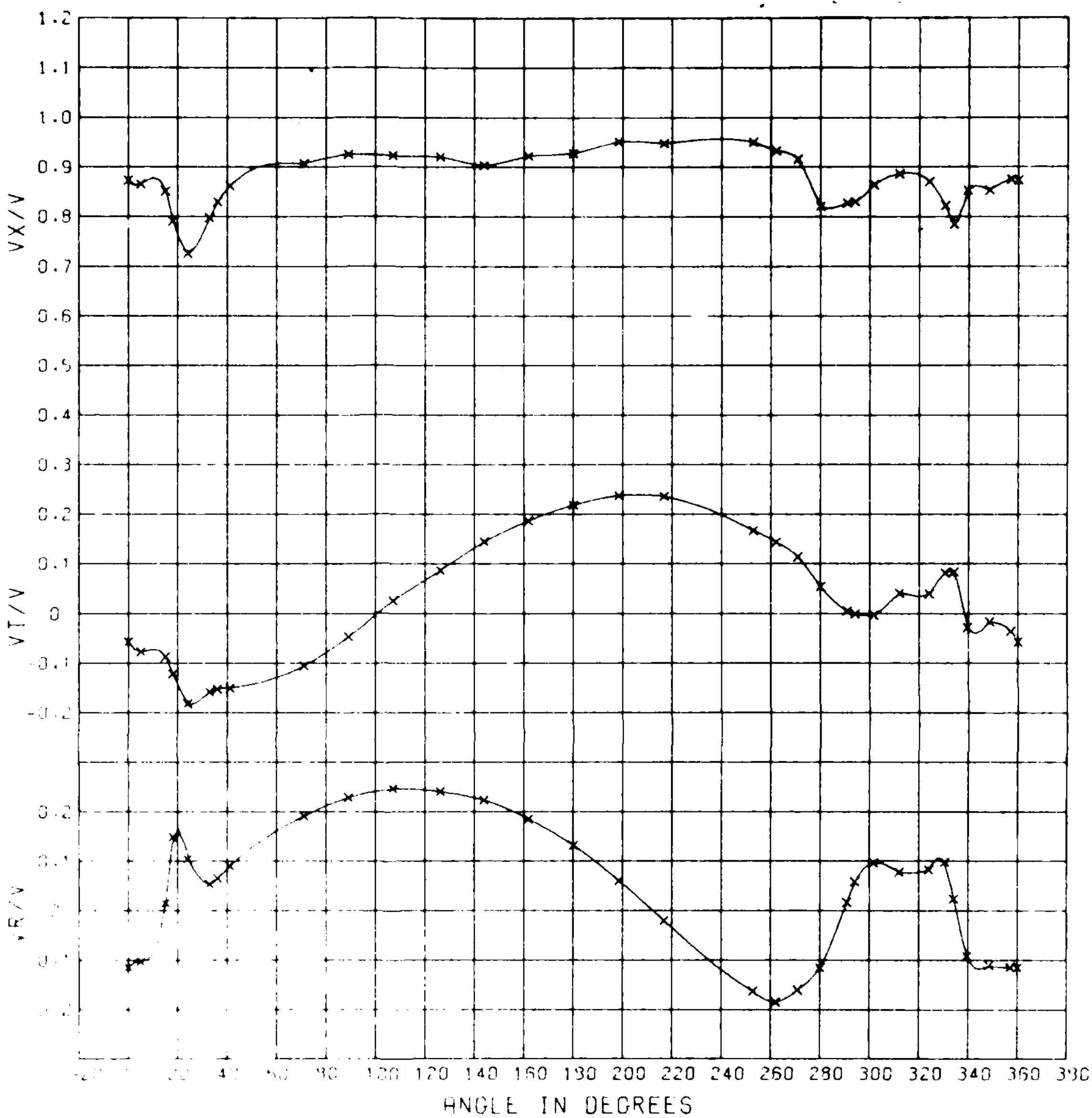


Figure 51 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.711 for Experiment 185

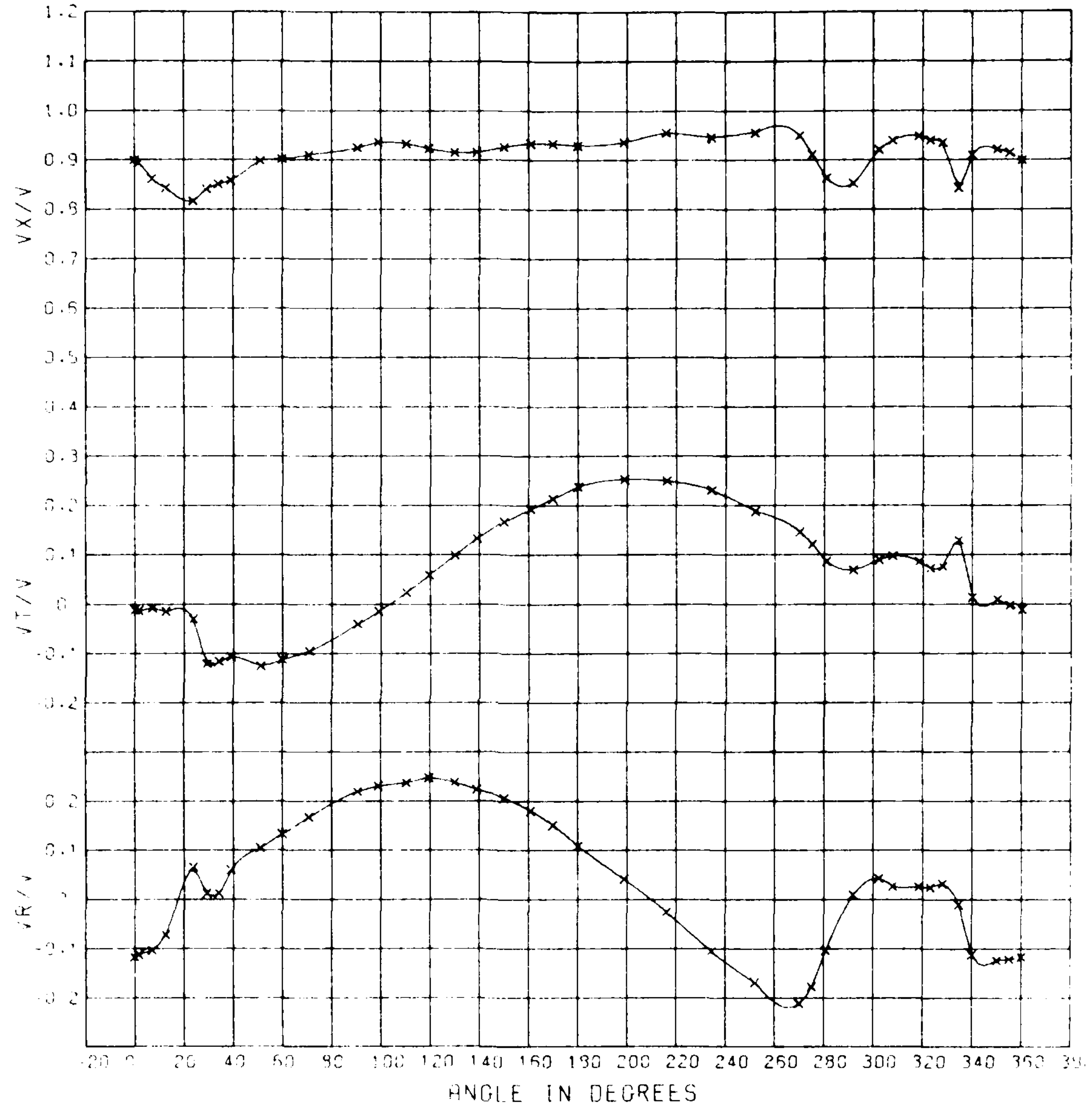


Figure 52 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity Component Ratios - Radius Ratio = 0.910 for Experiment 185

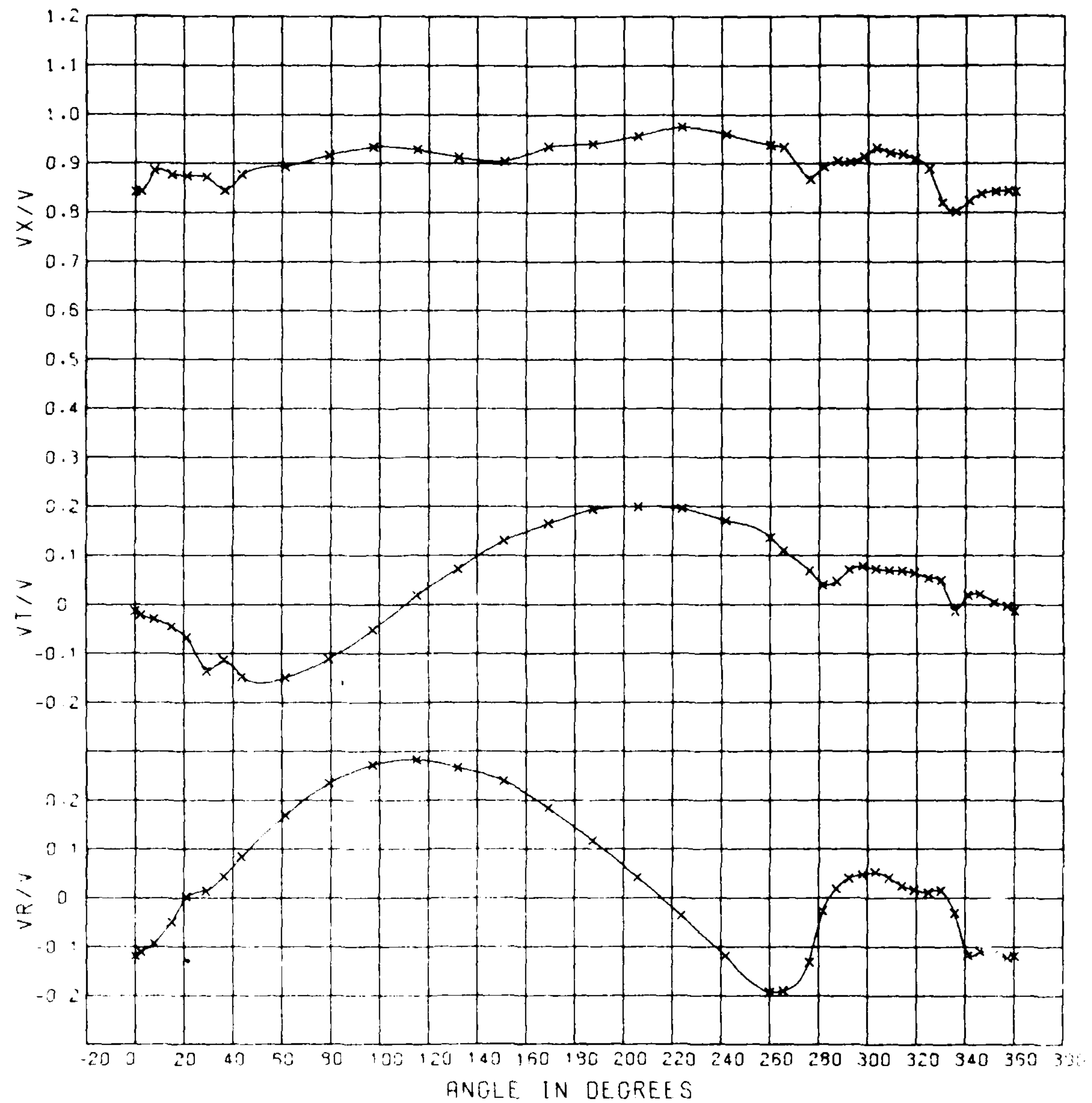


Figure 53 - Circumferential Distribution of the Longitudinal, Tangential, and Radial Velocity component Ratios - Radius Ratio = 1.082 for Experiment 185

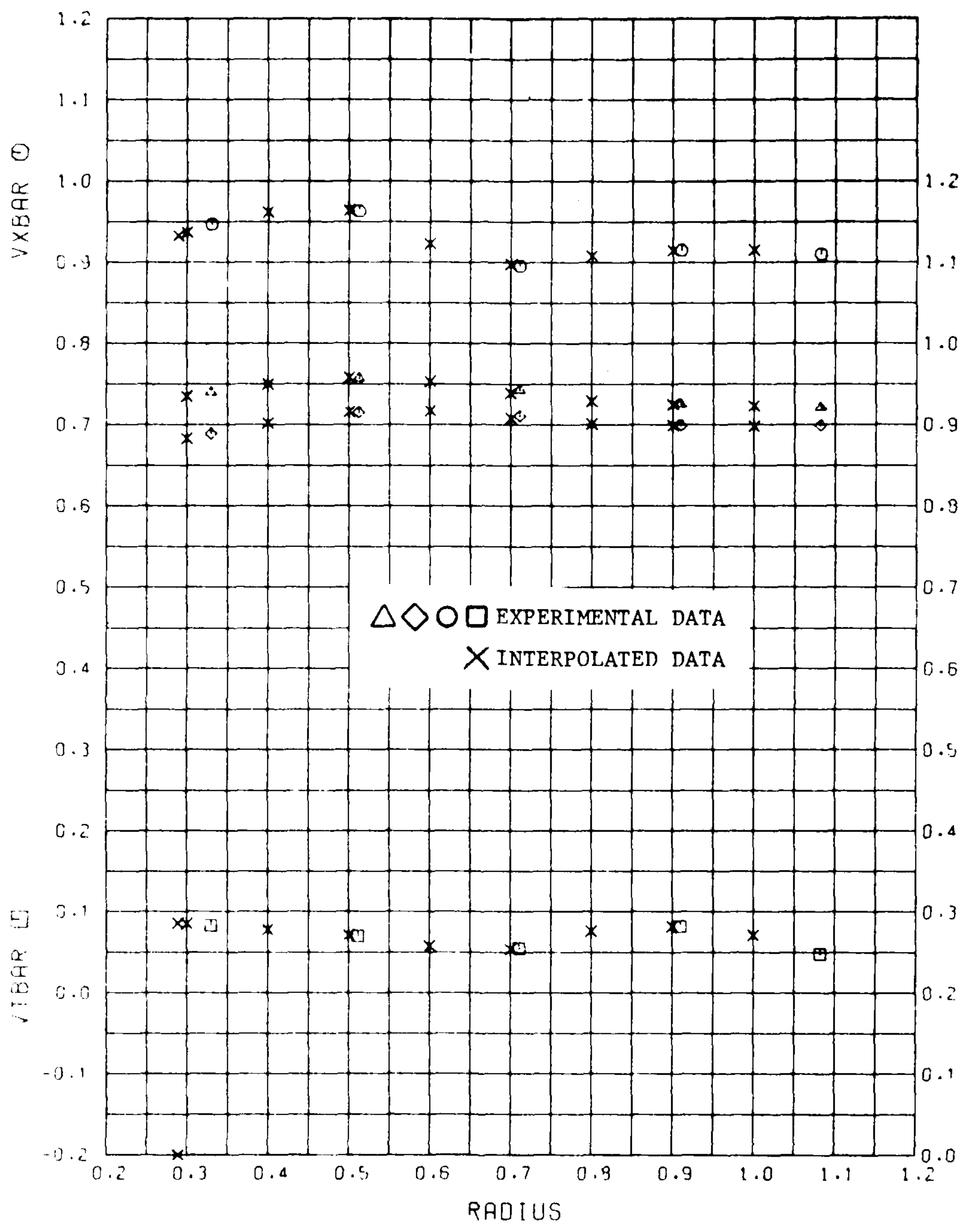


Figure 54 - Radial Distribution of the Mean Velocity Component Ratios for Experiment 185

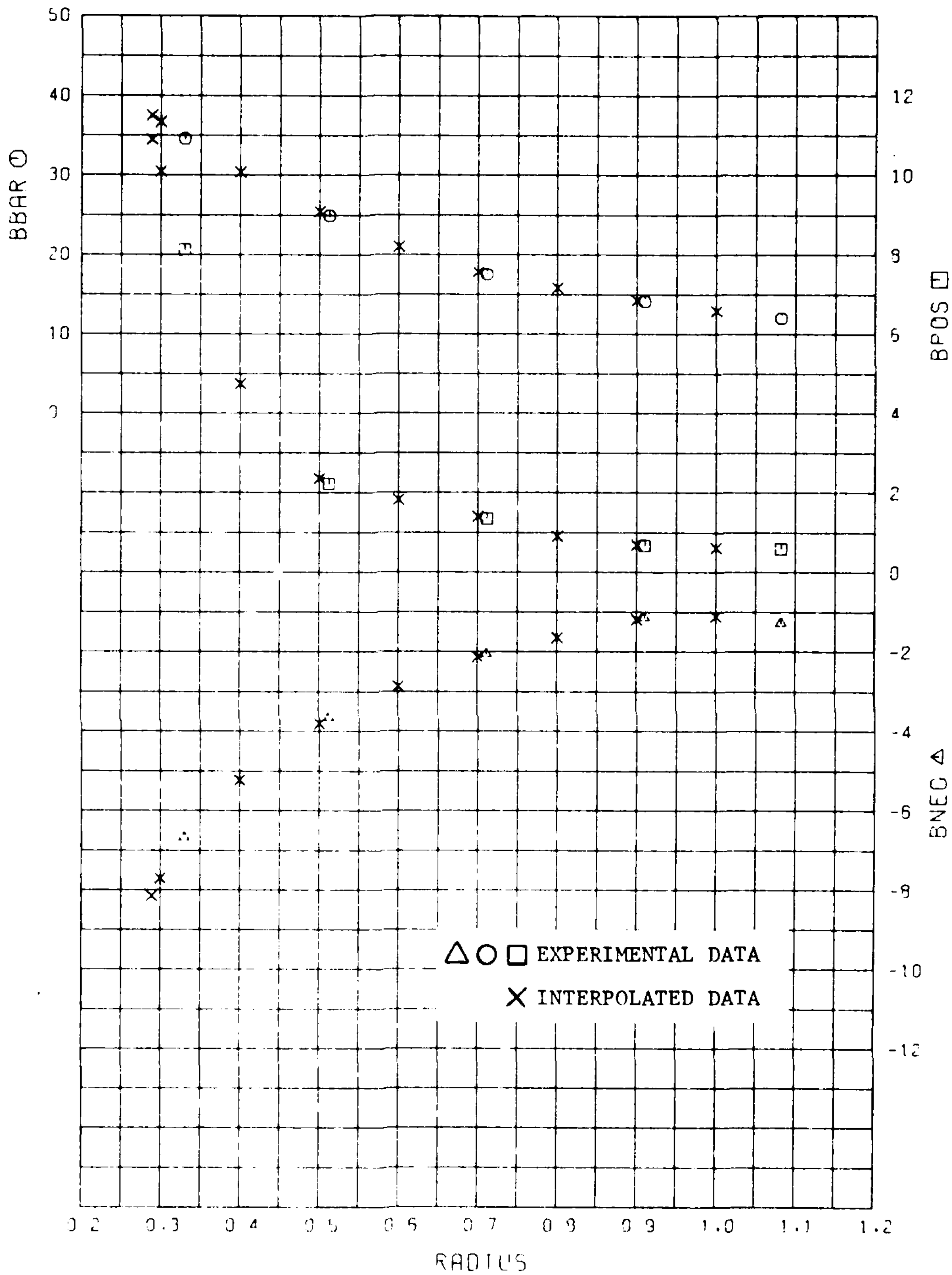
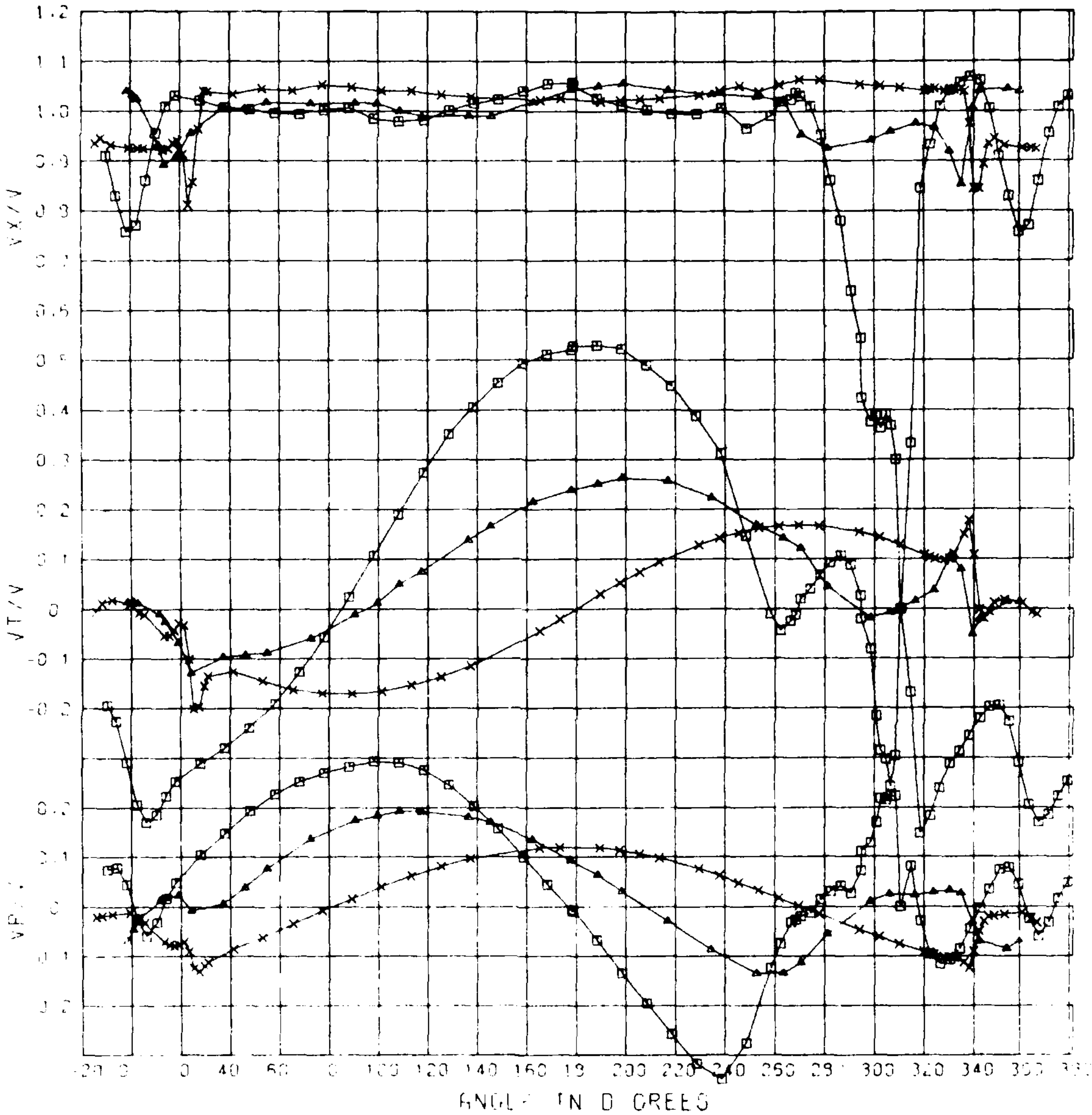


Figure 55 - Radial Distribution of the Mean Advance Angle and Advance Angle Variations for Experiment 185



× WAKE SURVEY OF MODEL 4383 WITHOUT BASS DYN BOAT-EXP 178
□ WAKE SURVEY OF MODEL 4383 IN A TURN - EXP 180
▲ WAKE SURVEY OF MODEL 4383 WITH YAW ANGLE OF 8.5 DEGREES - EXP 184

0.512 RAD.

Figure 56 - Composite Plot of Velocity Component Ratios for Experiments 178, 180, and 184 for the 0.512 Radius

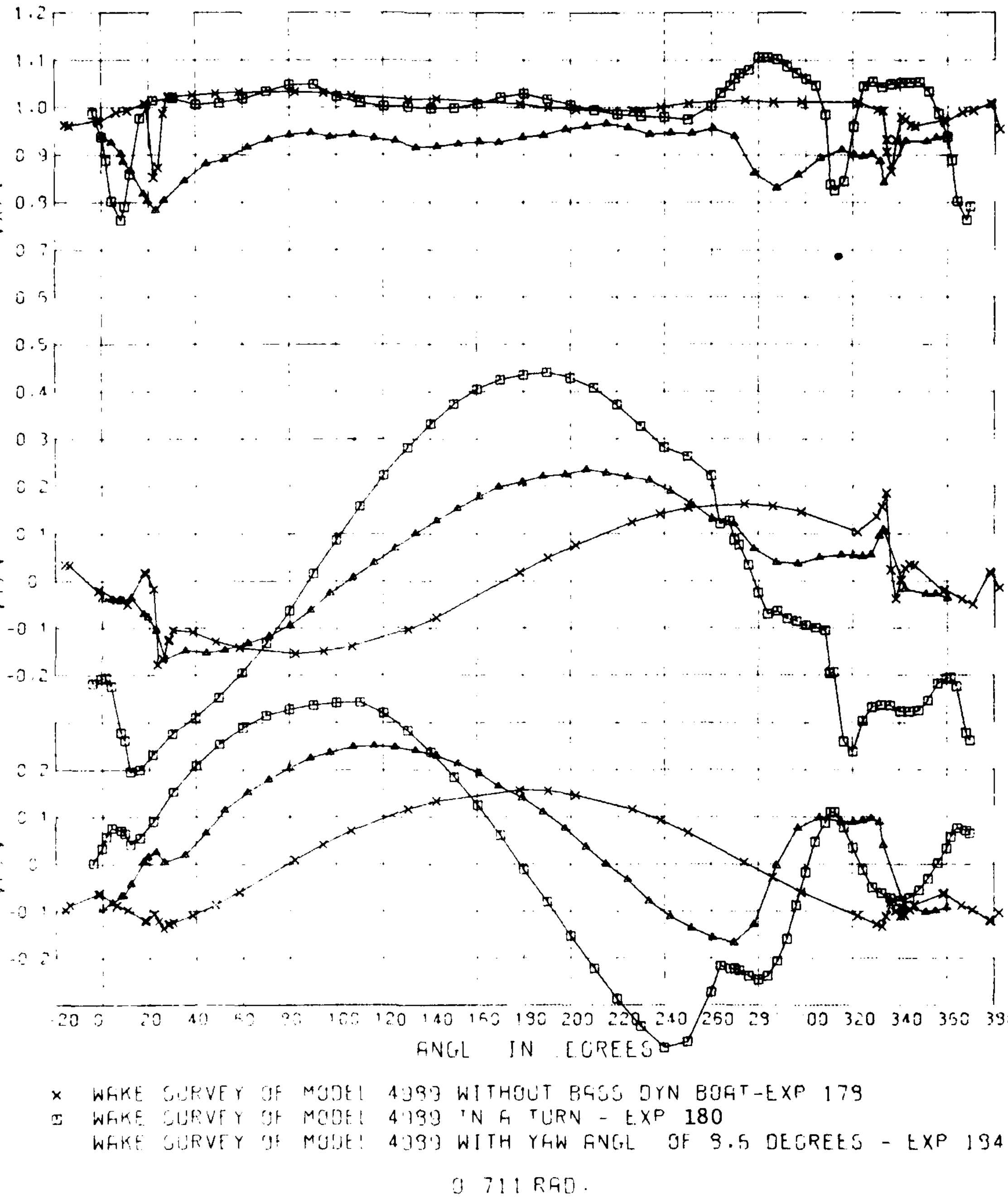


Figure 57 - Composite Plot of Velocity Component Ratios for Experiments 178, 180, and 184 for the 0.711 Radius

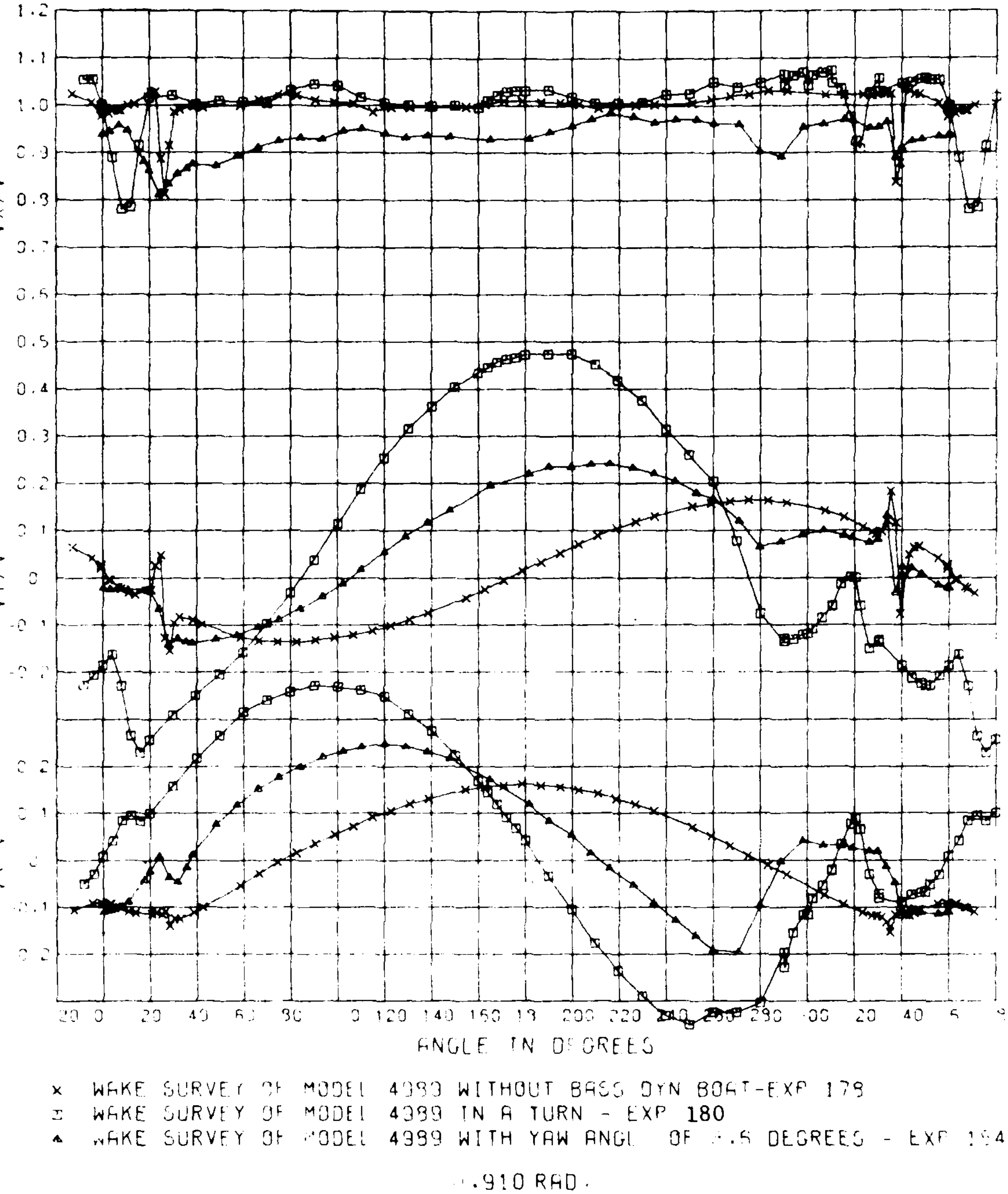


Figure 58 - Composite Plot of Velocity Component Ratios for Experiments 178, 180, and 184 for the 0.910 Radius

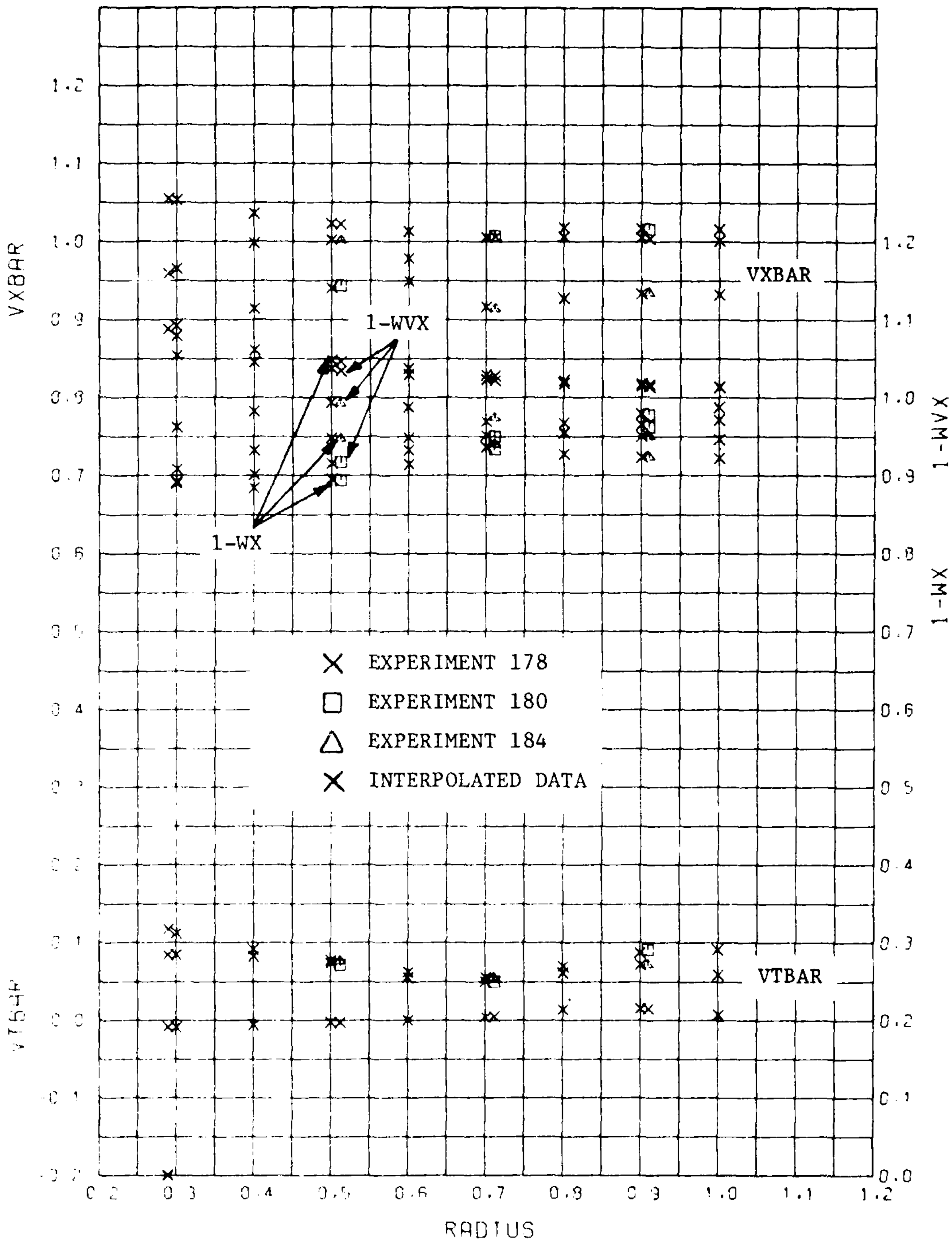


Figure 59 - Composite Plot of Mean Longitudinal, Tangential, and Volumetric Mean Wake of Experiments, 178, 180, and 184

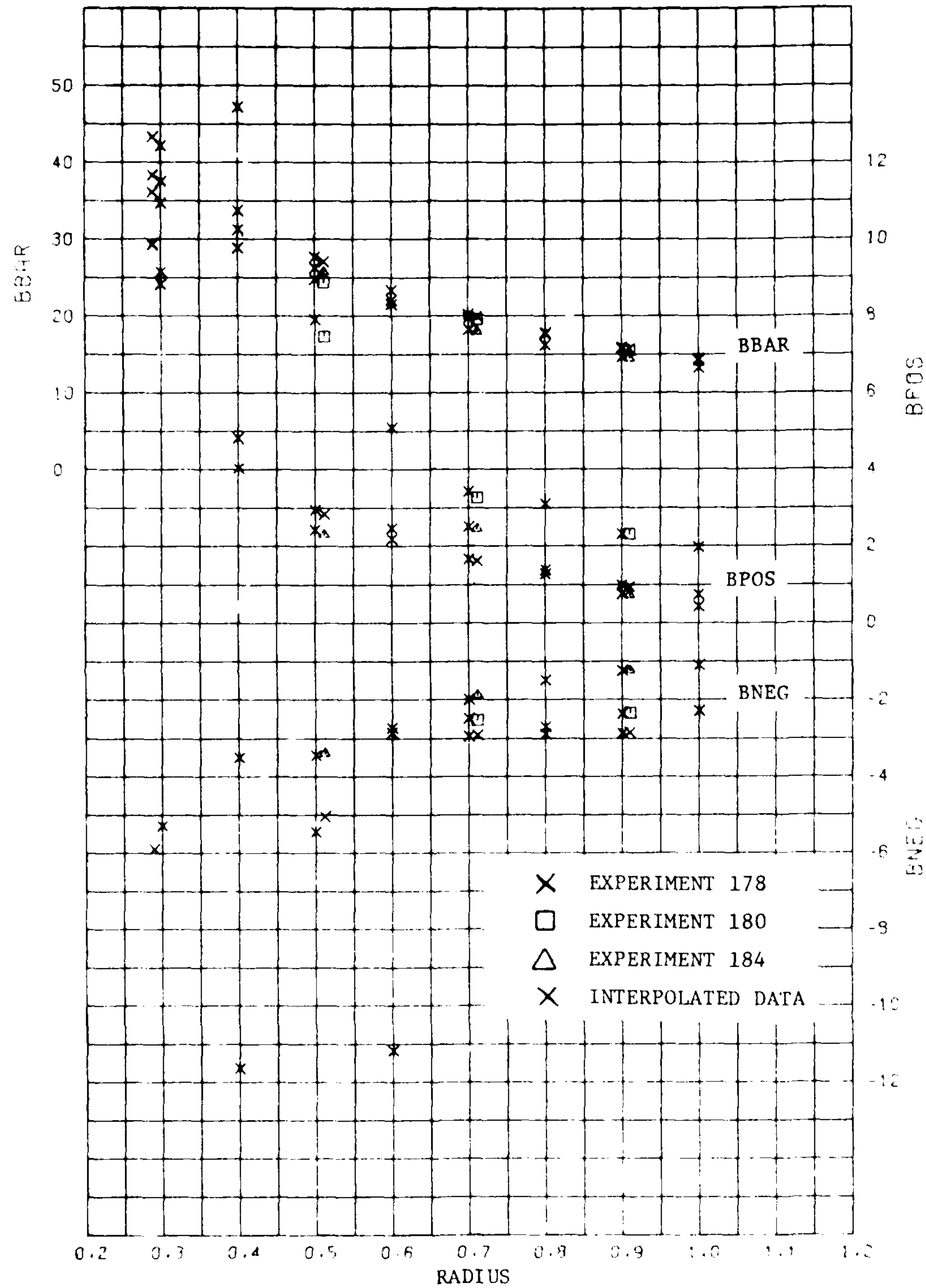


Figure 60 - Composite Plot of Mean Advance Angle (Beta) and Maximum Variations of Advance Angle of Experiments 178, 180, and 184

TABLE 1 - LIST OF WAKE SURVEY EXPERIMENTS WITH MODEL 4989

Experiment Number	Description	Facility
178	Conventional Wake Survey - Model Speed Corresponding to 28.6 knots	Carriage 1 Tow Basin
179	Wake Survey with Bass Dynamometer Boat at Speed Corresponding to 28.6 knots	Carriage 1 Tow Basin
180	High Speed Approach, Maximum Rudder Angle Turning Wake Survey	Rotating Arm Basin
181	High Speed Approach, Moderate Rudder Angle Turning Wake Survey	Rotating Arm Basin
182	Low Speed Approach, Maximum Rudder Angle Turning Wake Survey	Rotating Arm Basin
183	Low Speed Approach, Moderate Rudder Angle Turning Wake Survey	Rotating Arm Basin
184	Yawed Model, Straight Motion Wake Survey corresponding to Experiment 180 (High Speed Approach, Maximum Rudder Angle)	Carriage 1 Tow Basin
185	Yawed Model, Straight Motion Wake Survey corresponding to Experiment 182 (Low Speed Approach, Maximum Rudder Angle)	Carriage 1 Tow Basin

TABLE 2a - CONDITIONS FOR WAKE SURVEYS IN A TURN

Experiment Number		180	181	182	183
Ship Speed Approaching the Turn	knots	28.6	28.6	20.0	20.0
	m/s	14.7	14.7	10.3	10.3
Ship Speed in the Steady Portion of the Turn	knots	18.9	24.5	12.3	15.8
	m/s	9.72	12-6	6.33	8.13
Rudder Angle in Degrees		35	20	35	20
Yaw Angle in Degrees		8.6	2.9	9.0	8.0
Steady Turning Radius of Ship	feet	759	1185	702	1095
	m	231	361	214	334

TABLE 2b - CONDITIONS FOR YAWED WAKE SURVEYS

Experiment Number		184	185
Simulated Ship Speed in Steady Portion of the Turn	knots	18.9	12.3
	m/s	9.72	6.33
Rudder Angle in Degrees		35	35
Yaw Angle in Degrees		8.6	9.0

TABLE 3

Comparison of Conventional Tow Tank Wake Survey Data with Data from Rotating Arm Wake Survey and with Data from Yawed Model Wake Surv[illegible]

Parameter (Values taken at r/R = 0.7)	Expt. 178 Conventional Wake Survey	Expt. 180 Rotating Arm Wake Survey	Expt. 184 Yawed Model Wake Survey
Mean Longitudinal Velocity Comparison $\overline{V}_x/V$	1.006	1.005	0.916
Mean Tangential Velocity Comparison $\overline{V}_t/V$	0.004	0.050	0.055
Mean Radial Velocity Comparison V_R/V	0.019	0.030	0.064
Mean Hydrodynamic Pitch Angle [illegible]	20.17°	19.74°	18.17°
Maximum Positive Variation of [illegible] + [illegible]	1.66°	3.42°	2.50°
Maximum Negative Variation of [illegible] - [illegible]	-2.95°	-2.48°	-1.99°
First Harmonic of Longitudinal	-0.0004	0.0109	[illegible]
First Harmonic of Tangential	-0.1595	0.3953	[illegible]
Second Harmonic of Tangential	-0.0050	0.0054	0.0408
$1-W_x$	1.029	0.936	0.936

AD-A094 378 DAVID W TAYLOR NAVAL SHIP RESEARCH AND DEVELOPMENT CE--ETC F/G 13/10
PROPELLER-DISK WAKE SURVEY DATA FOR MODEL 4989 REPRESENTING THE--ETC(U)
DEC 80 W G DAY, R B HURWITZ
UNCLASSIFIED DTNSRDC/SPD-0011-21 NL

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APPENDIX A

VELOCITY COMPONENT RATIOS AND HARMONIC ANALYSIS
FOR EXPERIMENTS WITH AND WITHOUT THE
BASS DYNAMOMETER BOAT -
EXPERIMENTS 178 AND 179

TABLE A-1

INPUT DATA FOR HARMONIC ANALYSIS FOR FF 1088,
MODEL 4989, EXPERIMENT 178

INPUT DATA

RADIUS = .512

ANGLE	VX/V	VT/V	VR/V
-12.6	.935	-.006	-.021
-10.4	.945	.012	-.019
-6.2	.932	.018	-.016
1.0	.926	.011	-.013
4.8	.925	-.008	-.023
6.8	.924	-.012	-.033
14.8	.921	-.054	-.071
16.9	.924	-.054	-.077
18.8	.936	-.043	-.079
20.8	.939	-.029	-.077
22.8	.913	-.033	-.071
24.8	.811	-.101	-.090
26.6	.857	-.202	-.124
28.8	.963	-.198	-.131
31.0	1.040	-.155	-.119
32.5	1.039	-.135	-.112
42.7	1.034	-.126	-.085
54.6	1.045	-.145	-.062
66.9	1.041	-.163	-.035
78.7	1.053	-.170	-.008
90.7	1.048	-.171	.015
102.8	1.041	-.166	.040
114.8	1.040	-.154	.061
126.9	1.033	-.137	.081
138.8	1.028	-.115	.097
166.8	1.022	-.045	.118
174.9	1.026	-.021	.119
191.0	1.020	.030	.116
199.0	1.022	.052	.113
207.0	1.025	.074	.106
214.9	1.026	.094	.098
230.9	1.033	.128	.076
239.1	1.041	.142	.062
247.0	1.051	.152	.047
255.0	1.040	.163	.032
263.1	1.053	.166	.017
271.1	1.064	.168	.001
279.2	1.063	.166	-.015
295.4	1.054	.154	-.047
303.5	1.051	.143	-.061
311.5	1.048	.128	-.075
321.6	1.041	.107	-.091
323.7	1.044	.103	-.094
325.6	1.045	.100	-.097
329.5	1.040	.097	-.101
331.6	1.042	.100	-.101
333.5	1.043	.110	-.103
337.5	1.040	.149	-.112
339.5	.975	.178	-.124
341.5	.845	.107	-.090
343.7	.844	-.002	-.050
345.5	.893	-.021	-.030
347.4	.935	-.006	-.021
349.6	.945	.012	-.019
353.8	.932	.018	-.016
361.0	.926	.011	-.013
364.8	.925	-.008	-.023
366.8	.924	-.012	-.033

RADIUS = .711

ANGLE	VX/V	VT/V	VR/V
-15.9	.962	.033	-.098
-14.0	.960	.032	-.087
-1.9	.972	-.023	-.064
-1.2	.968	-.020	-.063
5.9	.988	-.040	-.088
10.6	.992	-.051	-.098
17.8	1.007	.017	-.121
18.5	1.006	.015	-.122
21.9	.851	-.018	-.107
23.8	.872	-.179	-.122
25.8	.986	-.167	-.138
27.8	1.021	-.127	-.129
28.4	1.022	-.126	-.128
30.0	1.022	-.106	-.125
38.3	1.025	-.110	-.110
48.2	1.028	-.130	-.087
58.2	1.031	-.143	-.060
82.1	1.032	-.155	.008
94.2	1.030	-.150	.040
106.2	1.024	-.140	.069
130.4	1.016	-.104	.116
142.4	1.018	-.078	.133
178.0	1.007	.017	.156
190.1	.999	.048	.154
202.0	.995	.075	.145
226.0	.993	.123	.115
237.9	1.000	.140	.092
249.9	1.008	.153	.065
273.9	1.015	.162	003
285.9	1.011	.157	-.029
298.0	1.011	.145	-.060
322.0	1.010	.102	-.111
330.0	.933	.135	-.129
332.3	.991	.155	-.134
333.9	.931	.184	-.113
334.0	.905	.184	-.113
336.0	.864	.022	-.082
338.0	.930	-.039	-.101
340.2	.979	.001	-.111
342.0	.973	.026	-.110
344.1	.962	.033	-.098
346.0	.960	.032	-.087
358.1	.972	-.023	-.064
358.8	.968	-.020	-.063
365.9	.988	-.040	-.088
370.6	.992	-.051	-.098
377.8	1.007	.017	-.121
378.5	1.006	.015	-.122
381.9	.953	-.016	-.105

RADIUS = .910

ANGLE	VX/V	VT/V	VR/V
-12.8	1.023	.065	-.106
-4.7	1.005	.042	-.091
-.9	.976	.020	-.091
-.7	.998	.027	-.090
2.5	.982	-.004	-.094
3.3	.990	-.004	-.092

TABLE A-1 CONTINUED

6.5	.988	-.021	-.099
7.5	.988	-.024	-.101
10.6	.999	-.033	-.109
13.5	1.001	-.037	-.112
20.5	1.026	-.026	-.114
22.5	1.029	.026	-.112
24.7	.887	.048	-.115
26.4	.812	-.128	-.110
28.5	.914	-.155	-.140
30.4	.985	-.096	-.125
32.7	.990	-.083	-.124
38.4	.997	-.089	-.111
42.4	.995	-.098	-.100
58.5	1.000	-.127	-.054
66.4	1.011	-.134	-.028
74.4	1.023	-.136	-.004
82.5	1.021	-.137	.016
90.4	1.012	-.132	.035
98.5	1.007	-.127	.054
106.5	1.005	-.121	.072
114.7	.986	-.113	.092
122.6	.996	-.101	.105
130.6	.996	-.088	.120
138.6	.997	-.074	.131
154.5	.997	-.042	.151
162.6	1.003	-.025	.156
170.7	1.009	-.005	.160
178.6	1.010	.015	.163
186.6	1.008	.034	.160
194.7	1.007	.052	.156
202.7	1.003	.071	.150
210.9	.995	.089	.142
218.6	.999	.104	.131
226.7	1.001	.118	.119
234.8	1.002	.130	.105
250.9	1.005	.150	.070
258.9	1.013	.157	.051
266.9	1.019	.161	.031
274.9	1.024	.165	.010
283.1	1.031	.163	-.010
291.1	1.031	.159	-.030
307.3	1.023	.142	-.073
315.3	1.022	.128	-.093
323.3	1.024	.108	-.110
327.2	1.022	.097	-.117
329.3	1.024	.094	-.118
331.3	1.030	.098	-.121
333.5	1.026	.121	-.132
335.2	1.024	.183	-.152
337.2	.837	.116	-.115
339.2	.878	-.077	-.113
341.5	1.036	.005	-.116
343.2	1.031	.049	-.117
345.2	1.024	.064	-.112
347.2	1.023	.065	-.106
355.3	1.005	.042	-.091
359.1	.976	.020	-.091
359.3	.998	.027	-.090
362.5	.982	-.004	-.094
363.3	.990	-.004	-.092
366.5	.988	-.021	-.099
367.5	.988	-.024	-.101
370.6	.999	-.033	-.109

RADIUS = 1.082

ANGLE	VX/V	VT/V	VR/V
-16.3	1.008	.043	-.131
-12.3	.999	.040	-.131
-4.3	.980	.029	-.124
-.3	.961	.004	-.119
7.9	.987	-.045	-.128
12.0	1.000	-.050	-.129
19.7	.993	-.052	-.119
20.0	1.000	-.050	-.118
21.7	1.012	-.019	-.118
23.6	.960	.050	-.111
24.0	.916	.066	-.113
25.5	.875	-.123	-.116
25.9	.807	-.185	-.125
28.0	.983	-.136	-.143
29.9	.983	-.097	-.139
31.9	.980	-.089	-.135
39.9	.969	-.104	-.114
45.9	.967	-.117	-.093
53.8	.971	-.133	-.068
53.8	.969	-.131	-.070
61.9	.988	-.142	-.044
69.8	1.008	-.148	-.018
77.8	.980	-.152	.007
77.9	1.024	-.149	.007
85.7	.993	-.149	.027
93.9	.995	-.145	.046
101.9	.996	-.139	.065
118.3	.994	-.121	.101
126.2	.993	-.110	.117
134.4	.999	-.098	.129
142.5	.987	-.082	.145
158.4	1.005	-.050	.160
166.3	1.011	-.033	.165
174.5	1.010	-.014	.170
182.5	1.006	.004	.169
190.6	1.002	.023	.166
198.4	1.002	.039	.161
214.5	.995	.069	.146
222.5	.995	.082	.135
230.6	1.001	.094	.120
238.9	1.001	.106	.105
246.7	1.003	.114	.090
254.8	1.009	.120	.072
263.0	1.010	.126	.051
271.3	.997	.134	.027
271.3	1.009	.132	.027
279.2	1.011	.133	.008
287.3	1.034	.131	-.016
295.4	1.016	.128	-.040
303.5	1.020	.121	-.062
311.6	1.017	.109	-.087
319.7	1.008	.093	-.110
323.7	.997	.084	-.121
325.6	.998	.080	-.126
329.7	.989	.069	-.135
331.6	1.001	.075	-.138
333.6	1.015	.113	-.135
335.6	.844	.194	-.100
337.8	.887	-.109	-.082
339.6	.983	-.011	-.130
341.6	1.004	.036	-.130
343.7	1.008	.043	-.131
347.7	.999	.040	-.131
355.7	.980	.029	-.124
359.7	.961	.004	-.119
367.9	.987	-.045	-.128
372.0	1.000	-.050	-.129

TABLE A-2 - LISTING OF THE MEAN VELOCITY COMPONENT RATIOS, THE MEAN ADVANCE ANGLES AND OTHER DERIVED QUANTITIES AT THE EXPERIMENTAL AND INTERPOLATED RADII FOR EXPERIMENT 178

RADIUS =	.512	.711	.910	1.082	.289	.300	.400	.500	.600	.700	.800	.900	1.000
VXBAR =	1.022	1.006	1.004	.996	1.055	1.053	1.036	1.023	1.013	1.006	1.006	1.005	1.001
VTBAR =	-.003	.005	.015	-.006	-.009	-.009	-.006	-.003	.000	.004	.014	.015	.007
VRBAR =	.013	.019	.022	.023	.001	.002	.008	.012	.016	.019	.021	.022	.023
1-WVX =	1.034	1.022	1.014	1.010	0.000	1.054	1.045	1.037	1.029	1.023	1.018	1.015	1.013
1-WX =	1.046	1.028	1.017	1.011	0.000	1.079	1.061	1.048	1.037	1.029	1.022	1.018	1.014
BBAR =	27.08	19.87	15.71	13.27	43.29	42.15	33.65	27.67	23.36	20.17	17.77	15.88	14.34
BPOS =	2.83	1.61	.95	.61	9.87	8.82	4.03	2.94	2.19	1.66	1.28	.98	.74
THETA =	80.00	77.50	77.50	72.50	20.00	20.00	80.00	80.00	80.00	77.50	77.50	77.50	75.00
BNEG =	-5.05	-2.92	-2.85	-1.84	-26.45	-24.58	-11.64	-5.46	-2.72	-2.95	-2.70	-2.88	-2.29
THETA =	342.50	335.00	337.50	335.00	25.00	25.00	25.00	342.50	22.50	335.00	337.50	337.50	337.50

VXBAR IS CIRCUMFERENTIAL MEAN LONGITUDINAL VELOCITY.
VTBAR IS CIRCUMFERENTIAL MEAN TANGENTIAL VELOCITY.
VRBAR IS CIRCUMFERENTIAL MEAN RADIAL VELOCITY.
1-WVX IS VOLUMETRIC MEAN WAKE VELOCITY WITHOUT TANGENTIAL CORRECTION.
1-WX IS VOLUMETRIC MEAN WAKE VELOCITY WITH TANGENTIAL CORRECTION.
BBAR IS MEAN ANGLE OF ADVANCE.
BPOS IS VARIATION BETWEEN THE MAXIMUM AND MEAN ADVANCE ANGLES (DELTA BETA PLUS).
BNEG IS VARIATION BETWEEN THE MINIMUM AND MEAN ADVANCE ANGLES (DELTA BETA MINUS).
THETA IS ANGLE IN DEGREES AT WHICH CORRESPONDING BPOS OR BNEG OCCURS.

TABLE A-3 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 178

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .512 AMPLITUDE =	-.0247	-.0409	-.0246	-.0136	-.0089	-.0031	.0006	.0060
RADIUS = .711 AMPLITUDE =	-.0087	-.0189	-.0118	-.0030	-.0011	.0027	.0066	.0069
RADIUS = .910 AMPLITUDE =	-.0012	-.0095	-.0091	.0056	.0044	.0036	.0020	.0049
RADIUS = 1.082 AMPLITUDE =	-.0096	-.0082	-.0068	.0043	.0033	.0055	.0011	.0001

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .512 AMPLITUDE =	.0081	.0067	.0045	.0051	.0025	-.0005	-.0019	-.0023
RADIUS = .711 AMPLITUDE =	.0059	.0040	.0014	-.0010	-.0036	-.0054	-.0063	-.0062
RADIUS = .910 AMPLITUDE =	.0032	.0013	-.0007	-.0052	-.0059	-.0059	-.0062	-.0054
RADIUS = 1.082 AMPLITUDE =	.0018	.0011	-.0002	-.0060	-.0063	-.0047	-.0051	-.0046

TABLE A-4 – HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 178

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .289 AMPLITUDE =	-.0527	-.0805	-.0509	-.0279	-.0205	-.0153	-.0187	.0015
RADIUS = .300 AMPLITUDE =	-.0511	-.0781	-.0493	-.0271	-.0199	-.0145	-.0174	.0018
RADIUS = .400 AMPLITUDE =	-.0375	-.0588	-.0362	-.0205	-.0144	-.0084	-.0074	.0042
RADIUS = .500 AMPLITUDE =	-.0259	-.0426	-.0257	-.0143	-.0094	-.0036	-.0001	.0058
RADIUS = .600 AMPLITUDE =	-.0166	-.0296	-.0177	-.0087	-.0051	.0001	.0046	.0067
RADIUS = .700 AMPLITUDE =	-.0094	-.0198	-.0122	-.0035	-.0014	.0025	.0065	.0069
RADIUS = .800 AMPLITUDE =	-.0030	-.0137	-.0105	.0022	.0023	.0029	.0041	.0065
RADIUS = .900 AMPLITUDE =	-.0011	-.0098	-.0092	.0054	.0043	.0035	.0022	.0051
RADIUS = 1.000 AMPLITUDE =	-.0039	-.0080	-.0079	.0059	.0045	.0044	.0012	.0028

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .289 AMPLITUDE =	.0099	.0097	.0092	.0144	.0139	.0103	.0083	.0076
RADIUS = .300 AMPLITUDE =	.0098	.0095	.0090	.0139	.0132	.0096	.0077	.0070
RADIUS = .400 AMPLITUDE =	.0091	.0082	.0067	.0095	.0076	.0042	.0025	.0019
RADIUS = .500 AMPLITUDE =	.0082	.0068	.0047	.0056	.0030	-.0001	-.0015	-.0019
RADIUS = .600 AMPLITUDE =	.0072	.0055	.0030	.0022	-.0007	-.0033	-.0044	-.0046
RADIUS = .700 AMPLITUDE =	.0061	.0042	.0015	-.0008	-.0034	-.0053	-.0062	-.0061
RADIUS = .800 AMPLITUDE =	.0045	.0025	.0001	-.0034	-.0049	-.0059	-.0064	-.0059
RADIUS = .900 AMPLITUDE =	.0033	.0014	-.0007	-.0051	-.0059	-.0059	-.0062	-.0055
RADIUS = 1.000 AMPLITUDE =	.0024	.0010	-.0007	-.0060	-.0063	-.0055	-.0057	-.0050

TABLE A-5 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 178

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .512 AMPLITUDE =	-.1739	-.0071	-.0073	-.0044	-.0036	-.0003	.0022	.0049
RADIUS = .711 AMPLITUDE =	-.1588	-.0060	-.0017	.0000	.0008	.0020	.0043	.0059
RADIUS = .910 AMPLITUDE =	-.1502	-.0097	-.0018	.0011	.0004	.0002	.0001	.0003
RADIUS = 1.082 AMPLITUDE =	-.1409	-.0099	-.0017	.0010	-.0003	-.0008	-.0009	-.0006

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .512 AMPLITUDE =	.0066	.0071	.0056	.0038	.0013	-.0010	-.0030	-.0039
RADIUS = .711 AMPLITUDE =	.0059	.0043	.0013	-.0019	-.0049	-.0069	-.0077	-.0074
RADIUS = .910 AMPLITUDE =	-.0000	-.0010	-.0019	-.0030	-.0044	-.0053	-.0052	-.0045
RADIUS = 1.082 AMPLITUDE =	-.0011	-.0013	-.0018	-.0027	-.0038	-.0044	-.0043	-.0038

TABLE A-6 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 178

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .289 AMPLITUDE =	-.1984	-.0141	-.0203	-.0132	-.0140	-.0080	-.0077	-.0038
RADIUS = .300 AMPLITUDE =	-.1970	-.0136	-.0195	-.0127	-.0134	-.0075	-.0070	-.0032
RADIUS = .400 AMPLITUDE =	-.1852	-.0099	-.0129	-.0083	-.0081	-.0035	-.0018	.0016
RADIUS = .500 AMPLITUDE =	-.1750	-.0073	-.0078	-.0047	-.0040	-.0006	.0019	.0047
RADIUS = .600 AMPLITUDE =	-.1664	-.0060	-.0041	-.0020	-.0011	.0012	.0039	.0062
RADIUS = .700 AMPLITUDE =	-.1595	-.0059	-.0018	-.0001	.0007	.0020	.0044	.0060
RADIUS = .800 AMPLITUDE =	-.1553	-.0081	-.0017	.0007	.0007	.0011	.0020	.0027
RADIUS = .900 AMPLITUDE =	-.1507	-.0096	-.0018	.0011	.0005	.0003	.0002	.0004
RADIUS = 1.000 AMPLITUDE =	-.1455	-.0101	-.0017	.0012	.0001	-.0004	-.0007	-.0006

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .289 AMPLITUDE =	.0011	.0071	.0117	.0158	.0165	.0147	.0109	.0077
RADIUS = .300 AMPLITUDE =	.0016	.0072	.0114	.0150	.0156	.0137	.0100	.0069
RADIUS = .400 AMPLITUDE =	.0047	.0075	.0085	.0091	.0079	.0057	.0028	.0009
RADIUS = .500 AMPLITUDE =	.0064	.0072	.0059	.0043	.0019	-.0004	-.0025	-.0035
RADIUS = .600 AMPLITUDE =	.0069	.0062	.0036	.0007	-.0023	-.0046	-.0060	-.0062
RADIUS = .700 AMPLITUDE =	.0061	.0046	.0015	-.0017	-.0048	-.0068	-.0077	-.0074
RADIUS = .800 AMPLITUDE =	.0026	.0013	-.0006	-.0026	-.0047	-.0061	-.0064	-.0058
RADIUS = .900 AMPLITUDE =	.0002	-.0008	-.0018	-.0030	-.0044	-.0054	-.0053	-.0046
RADIUS = 1.000 AMPLITUDE =	-.0011	-.0016	-.0022	-.0030	-.0041	-.0048	-.0046	-.0039

TABLE A-7

INPUT DATA FOR HARMONIC ANALYSIS FOR FF 1088, MODEL 4989, EXPERIMENT 179

INPUT DATA

RADIUS = .512

ANGLE	VX/V	VT/V	VR/V
-14.0	.772	0.000	-.036
-12.2	.784	.017	-.035
-10.2	.788	.024	-.034
-6.1	.782	.030	-.028
-1.9	.772	.023	-.028
.3	.769	.013	-.032
4.2	.778	.006	-.044
8.3	.769	-.011	-.059
12.2	.768	-.027	-.080
16.3	.766	-.007	-.084
18.2	.765	.003	-.083
20.4	.730	-.016	-.087
22.3	.655	-.105	-.100
24.2	.701	-.214	-.136
26.3	.826	-.184	-.153
28.3	.888	-.138	-.142
32.3	.896	-.102	-.126
36.2	.899	-.098	-.119
40.3	.897	-.105	-.112
44.3	.898	-.112	-.107
56.5	.892	-.135	-.086
68.5	.904	-.149	-.062
80.5	.907	-.156	-.036
92.5	.909	-.157	-.013
104.6	.834	-.153	.009
116.5	.893	-.138	.028
128.5	.886	-.120	.046
140.6	.877	-.096	.060
160.8	.865	-.045	.077
164.7	.866	-.034	.078
168.8	.869	-.022	.079
180.8	.868	.013	.081
186.7	.865	.031	.080
192.7	.867	.049	.077
204.6	.861	.085	.070
216.4	.880	.113	.057
228.1	.893	.137	.041
240.0	.905	.156	.022
252.1	.908	.172	.001
263.8	.920	.175	-.020
275.9	.919	.173	-.043
288.0	.918	.165	-.066
312.0	.915	.127	-.105
324.0	.920	.103	-.119
332.0	.905	.123	-.121
333.9	.902	.149	-.125
335.8	.887	.177	-.134
335.9	.857	.180	-.136
338.1	.655	.179	-.147
339.8	.645	.074	-.101
341.8	.686	-.010	-.060
343.8	.736	-.017	-.042
346.0	.772	0.000	-.036
347.8	.784	.017	-.035
349.8	.788	.024	-.034
353.9	.782	.030	-.028
358.1	.772	.023	-.028
360.3	.769	.013	-.032
364.2	.778	.006	-.044
368.3	.769	-.011	-.059

RADIUS = .711

ANGLE	VX/V	VT/V	VR/V
-17.5	.841	.014	-.113
-13.6	.839	.014	-.094
-9.5	.842	0.000	-.077
-5.5	.848	-.016	-.069
.5	.849	-.037	-.076
1.8	.853	-.036	-.078
2.6	.858	-.041	-.077
3.8	.856	-.045	-.088
6.6	.862	-.045	-.091
7.8	.861	-.052	-.103
10.0	.868	-.052	-.113
10.5	.875	-.055	-.112
12.0	.876	-.060	-.121
13.9	.883	-.052	-.131
16.0	.903	-.025	-.130
18.1	.885	.014	-.126
20.0	.799	.031	-.123
22.0	.737	-.046	-.124
24.0	.797	-.183	-.148
26.0	.902	-.144	-.152
28.0	.911	-.113	-.149
30.0	.916	-.101	-.145
32.0	.913	-.098	-.140
42.1	.910	-.120	-.125
48.0	.909	-.131	-.112
60.1	.907	-.151	-.084
66.0	.908	-.157	-.069
72.1	.908	-.160	-.054
78.1	.907	-.163	-.037
84.0	.908	-.162	-.022
96.0	.904	-.158	.008
102.2	.907	-.153	.022
122.4	.892	-.128	.063
130.4	.892	-.113	.075
138.3	.877	-.098	.088
146.3	.879	-.079	.096
154.2	.884	-.058	.102
162.2	.875	-.039	.107
170.2	.878	-.015	.109
178.3	.877	.007	.108
194.3	.864	.047	.105
202.4	.867	.066	.098
218.3	.868	.098	.091
226.4	.874	.111	.069
234.3	.870	.125	.056
242.3	.881	.133	.039
258.0	.878	.148	.003
268.1	.888	.148	-.021
278.0	.892	.146	-.047
288.1	.892	.139	-.071
306.1	.890	.114	-.112
314.1	.892	.097	-.126
322.2	.899	.082	-.136
330.2	.903	.101	-.152
332.3	.888	.142	-.158
334.3	.760	.139	-.135
336.2	.737	-.010	-.112
338.2	.797	-.047	-.112
340.3	.844	-.011	-.118
342.5	.841	.014	-.113
346.4	.839	.014	-.094
350.5	.842	0.000	-.077
354.5	.848	-.016	-.069
360.5	.849	-.037	-.076
361.8	.853	-.036	-.078
362.6	.858	-.041	-.077
363.8	.856	-.045	-.088

TABLE A-7 CONTINUED

RADIUS = .910

ANGLE	VX/V	VT/V	VR/V
-7.8	.890	.046	-.104
-3.8	.890	.032	-.102
-.2	.892	.010	-.103
-.1	.900	.017	-.103
4.3	.892	-.007	-.109
8.2	.897	-.016	-.120
12.3	.904	-.024	-.127
16.0	.911	-.026	-.133
17.8	.917	-.022	-.133
20.2	.939	.007	-.133
20.3	.939	.008	-.136
21.8	.898	.066	-.134
24.4	.742	.027	-.132
28.4	.905	-.091	-.158
32.3	.901	-.058	-.153
36.3	.904	-.067	-.146
40.3	.906	-.076	-.138
44.1	.905	-.087	-.131
48.4	.899	-.096	-.120
52.2	.906	-.104	-.109
56.3	.907	-.111	-.099
60.3	.907	-.116	-.085
66.1	.908	-.123	-.069
78.0	.921	-.126	-.035
84.3	.915	-.126	-.020
90.1	.926	-.124	-.007
96.2	.926	-.120	.006
102.1	.918	-.115	.016
108.2	.909	-.110	.030
114.3	.897	-.104	.043
120.2	.900	-.094	.052
126.1	.895	-.086	.064
132.6	.883	-.076	.074
138.2	.894	-.065	.080
144.4	.887	-.053	.088
156.4	.888	-.028	.098
168.5	.894	0.000	.104
180.6	.879	.031	.107
192.5	.884	.060	.103
204.4	.890	.086	.093
216.1	.892	.109	.080
239.9	.906	.148	.040
246.1	.909	.156	.027
251.7	.919	.161	.015
257.9	.936	.165	.003
263.6	.930	.167	-.009
269.9	.934	.169	-.024
282.3	.923	.168	-.058
287.8	.923	.164	-.071
294.2	.928	.157	-.086
299.9	.928	.150	-.101
306.2	.928	.140	-.114
311.9	.931	.129	-.127
316.4	.926	.118	-.135
320.0	.932	.107	-.140
324.0	.935	.096	-.143
328.2	.930	.094	-.148
332.0	.923	.174	-.180
335.6	.884	-.056	-.121
337.5	.655	-.033	-.122
340.0	.884	.048	-.134
343.7	.910	.063	-.119
348.1	.891	.057	-.105
352.2	.890	.046	-.104
356.2	.890	.032	-.102
359.8	.892	.010	-.103
359.9	.900	.017	-.103
364.3	.892	-.007	-.109
368.2	.897	-.016	-.120
372.3	.904	-.024	-.127
376.0	.911	-.026	-.133

RADIUS = 1.082

ANGLE	VX/V	VT/V	VR/V
-10.0	.879	.026	-.127
0.0	.866	0.000	-.124
10.0	.879	-.026	-.127
17.8	.898	-.042	-.124
21.2	.835	.047	-.123
23.1	.696	-.181	-.150
25.1	.766	-.137	-.176
27.0	.882	-.089	-.156
29.1	.885	-.084	-.154
29.4	.881	-.083	-.151
31.1	.881	-.087	-.149
32.9	.879	-.092	-.147
44.9	.873	-.121	-.119
50.8	.876	-.135	-.103
56.9	.881	-.143	-.085
62.6	.886	-.152	-.069
92.4	.898	-.152	.012
104.8	.897	-.142	.038
116.4	.894	-.128	.061
128.6	.896	-.108	.080
160.5	.893	-.047	.115
172.6	.902	-.019	.118
184.6	.897	.009	.117
187.4	.902	.019	.118
199.5	.893	.047	.115
231.4	.896	.108	.080
243.6	.894	.128	.061
255.2	.897	.142	.038
267.6	.898	.152	.012
297.4	.886	.152	-.069
303.1	.881	.143	-.085
309.2	.876	.135	-.103
315.1	.873	.121	-.119
327.1	.879	.092	-.147
328.9	.881	.087	-.149
330.6	.881	.083	-.151
330.9	.885	.084	-.154
333.0	.882	.089	-.156
334.9	.766	.137	-.176
336.9	.696	.161	-.150
338.8	.835	-.047	-.123
342.2	.898	.042	-.124
350.0	.879	.026	-.127
360.0	.866	0.000	-.124
370.0	.879	-.026	-.127

TABLE A-8 - LISTING OF THE MEAN VELOCITY COMPONENT RATIOS, THE MEAN ADVANCE ANGLES AND OTHER DERIVED QUANTITIES AT THE EXPERIMENTAL AND INTERPOLATED RADII FOR EXPERIMENT 179

RADIUS =	.512	.711	.910	1.082	.289	.300	.400	.500	.600	.700	.800	.900	1.000
VXBAR =	.875	.882	.903	.886	.883	.882	.877	.875	.876	.881	.897	.903	.899
VTBAR =	.008	-.006	.022	-.000	.073	.069	.034	.010	-.003	-.006	.014	.022	.016
VRBAR =	-.018	-.014	-.020	-.007	-.033	-.032	-.024	-.019	-.015	-.014	-.020	-.020	-.015
1-WVX =	.878	.877	.884	.888	0.000	.883	.879	.877	.876	.877	.880	.885	.888
1-WX =	.861	.873	.881	.885	0.000	.840	.852	.861	.867	.872	.877	.881	.885
BBAR =	23.53	17.65	14.17	11.84	36.30	35.42	28.76	24.01	20.52	17.89	15.94	14.32	12.90
BPOS =	2.74	1.49	.94	.59	11.15	10.41	4.17	2.86	2.08	1.54	1.19	.96	.76
THETA =	87.50	82.50	92.50	87.50	335.00	335.00	92.50	90.00	85.00	82.50	92.50	92.50	92.50
BNEG =	-6.12	-3.14	-3.64	-2.32	-26.32	-24.72	-13.49	-6.71	-3.28	-3.21	-3.20	-3.65	-3.20
THETA =	340.00	335.00	337.50	337.50	340.00	340.00	340.00	340.00	22.50	335.00	337.50	337.50	337.50

VXBAR IS CIRCUMFERENTIAL MEAN LONGITUDINAL VELOCITY.
VTBAR IS CIRCUMFERENTIAL MEAN TANGENTIAL VELOCITY.
VRBAR IS CIRCUMFERENTIAL MEAN RADIAL VELOCITY.
1-WVX IS VOLUMETRIC MEAN WAKE VELOCITY WITHOUT TANGENTIAL CORRECTION.
1-WX IS VOLUMETRIC MEAN WAKE VELOCITY WITH TANGENTIAL CORRECTION.
BBAR IS MEAN ANGLE OF ADVANCE.
BPOS IS VARIATION BETWEEN THE MAXIMUM AND MEAN ADVANCE ANGLES (DELTA BETA PLUS).
BNEG IS VARIATION BETWEEN THE MINIMUM AND MEAN ADVANCE ANGLES (DELTA BETA MINUS).
THETA IS ANGLE IN DEGREES AT WHICH CORRESPONDING BPOS OR BNEG OCCURS.

TABLE A-9 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 179

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .512 AMPLITUDE =	-.0231	-.0499	-.0274	-.0192	-.0120	-.0026	.0019	.0125
RADIUS = .711 AMPLITUDE =	-.0016	-.0199	-.0115	-.0058	-.0041	.0012	.0038	.0063
RADIUS = .910 AMPLITUDE =	.0054	-.0193	-.0051	.0021	-.0008	.0003	.0068	.0060
RADIUS = 1.082 AMPLITUDE =	-.0156	-.0081	-.0011	.0052	.0034	.0045	.0035	.0050

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .512 AMPLITUDE =	.0137	.0128	.0112	.0079	.0023	-.0030	-.0046	-.0060
RADIUS = .711 AMPLITUDE =	.0076	.0065	.0033	.0012	-.0027	-.0046	-.0076	-.0066
RADIUS = .910 AMPLITUDE =	.0041	.0023	.0024	-.0022	-.0045	-.0061	-.0058	-.0069
RADIUS = 1.082 AMPLITUDE =	.0034	.0017	.0002	-.0039	-.0055	-.0083	-.0083	-.0087

TABLE A-10 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 179

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .289 AMPLITUDE =	-.0644	-.1185	-.0563	-.0410	-.0263	-.0124	.0012	.0263
RADIUS = .300 AMPLITUDE =	-.0619	-.1142	-.0546	-.0398	-.0255	-.0118	.0012	.0254
RADIUS = .400 AMPLITUDE =	-.0416	-.0797	-.0404	-.0293	-.0185	-.0068	.0014	.0185
RADIUS = .500 AMPLITUDE =	-.0249	-.0526	-.0286	-.0202	-.0126	-.0030	.0019	.0131
RADIUS = .600 AMPLITUDE =	-.0118	-.0330	-.0192	-.0126	-.0080	-.0003	.0026	.0091
RADIUS = .700 AMPLITUDE =	-.0024	-.0208	-.0121	-.0063	-.0044	.0011	.0037	.0065
RADIUS = .800 AMPLITUDE =	.0057	-.0213	-.0084	-.0017	-.0028	.0000	.0060	.0063
RADIUS = .900 AMPLITUDE =	.0058	-.0196	-.0054	.0018	-.0010	.0002	.0068	.0060
RADIUS = 1.000 AMPLITUDE =	-.0025	-.0147	-.0028	.0042	.0013	.0019	.0057	.0056

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .289 AMPLITUDE =	.0237	.0225	.0283	.0194	.0118	-.0011	.0044	-.0116
RADIUS = .300 AMPLITUDE =	.0231	.0219	.0273	.0187	.0112	-.0012	.0038	-.0114
RADIUS = .400 AMPLITUDE =	.0183	.0173	.0187	.0131	.0065	-.0020	-.0008	-.0096
RADIUS = .500 AMPLITUDE =	.0141	.0133	.0119	.0084	.0027	-.0029	-.0043	-.0082
RADIUS = .600 AMPLITUDE =	.0107	.0097	.0068	.0045	-.0003	-.0037	-.0065	-.0072
RADIUS = .700 AMPLITUDE =	.0078	.0068	.0036	.0014	-.0025	-.0045	-.0075	-.0067
RADIUS = .800 AMPLITUDE =	.0057	.0041	.0031	-.0005	-.0036	-.0051	-.0061	-.0065
RADIUS = .900 AMPLITUDE =	.0042	.0024	.0024	-.0021	-.0044	-.0060	-.0057	-.0068
RADIUS = 1.000 AMPLITUDE =	.0035	.0017	.0014	-.0032	-.0051	-.0071	-.0066	-.0076

TABLE A-11 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 179

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .512 AMPLITUDE =	-.1698	-.0033	-.0060	-.0046	-.0032	.0002	.0031	.0059
RADIUS = .711 AMPLITUDE =	-.1549	-.0023	.0005	.0017	.0017	.0024	.0030	.0036
RADIUS = .910 AMPLITUDE =	-.1447	-.0016	.0046	.0055	.0031	.0019	.0000	-.0006
RADIUS = 1.082 AMPLITUDE =	-.1558	-.0129	-.0005	.0025	.0002	.0005	-.0001	-.0016

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .512 AMPLITUDE =	.0087	.0090	.0077	.0052	.0020	-.0021	-.0054	-.0076
RADIUS = .711 AMPLITUDE =	.0038	.0028	.0011	-.0012	-.0032	-.0052	-.0063	-.0063
RADIUS = .910 AMPLITUDE =	-.0021	-.0035	-.0047	-.0054	-.0058	-.0054	-.0038	-.0018
RADIUS = 1.082 AMPLITUDE =	.0017	.0014	.0008	.0003	-.0007	-.0018	-.0027	-.0033

TABLE A-12 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 179

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .289 AMPLITUDE =	-.1921	-.0048	-.0163	-.0145	-.0127	-.0054	-.0003	.0061
RADIUS = .300 AMPLITUDE =	-.1909	-.0047	-.0157	-.0139	-.0121	-.0051	-.0000	.0062
RADIUS = .400 AMPLITUDE =	-.1803	-.0040	-.0108	-.0092	-.0074	-.0022	.0019	.0063
RADIUS = .500 AMPLITUDE =	-.1708	-.0034	-.0065	-.0050	-.0036	.0000	.0030	.0060
RADIUS = .600 AMPLITUDE =	-.1626	-.0028	-.0028	-.0015	-.0006	.0015	.0034	.0051
RADIUS = .700 AMPLITUDE =	-.1556	-.0024	.0002	.0014	.0015	.0024	.0031	.0038
RADIUS = .800 AMPLITUDE =	-.1473	-.0002	.0036	.0044	.0030	.0023	.0013	.0008
RADIUS = .900 AMPLITUDE =	-.1446	-.0013	.0046	.0055	.0032	.0019	.0001	-.0006
RADIUS = 1.000 AMPLITUDE =	-.1482	-.0061	.0029	.0047	.0021	.0012	-.0003	-.0002

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .289 AMPLITUDE =	.0133	.0157	.0160	.0150	.0110	.0048	-.0004	-.0051
RADIUS = .300 AMPLITUDE =	.0131	.0153	.0156	.0144	.0105	.0043	-.0008	-.0053
RADIUS = .400 AMPLITUDE =	.0112	.0124	.0117	.0098	.0061	.0009	-.0034	-.0069
RADIUS = .500 AMPLITUDE =	.0090	.0093	.0081	.0057	.0024	-.0018	-.0052	-.0076
RADIUS = .600 AMPLITUDE =	.0066	.0063	.0047	.0021	-.0007	-.0038	-.0062	-.0075
RADIUS = .700 AMPLITUDE =	.0041	.0032	.0014	-.0009	-.0030	-.0051	-.0063	-.0065
RADIUS = .800 AMPLITUDE =	-.0002	-.0016	-.0031	-.0045	-.0055	-.0059	-.0050	-.0035
RADIUS = .900 AMPLITUDE =	-.0020	-.0035	-.0048	-.0054	-.0059	-.0055	-.0039	-.0019
RADIUS = 1.000 AMPLITUDE =	-.0011	-.0021	-.0031	-.0035	-.0040	-.0039	-.0031	-.0020

APPENDIX B

VELOCITY COMPONENT RATIOS AND HARMONIC ANALYSIS
FOR ROTATING ARM WAKE SURVEYS -
EXPERIMENTS 180, 181, 182, AND 183

TABLE B-1

INPUT DATA FOR HARMONIC ANALYSIS FOR FF 1088, MODEL 4989, EXPERIMENT 180

INPUT DATA

RADIUS = .330

ANGLE	VX/V	VT/V	VR/V
-4.3	.735	-.469	-.004
0.0	.839	-.567	-.028
3.6	.965	-.501	-.034
7.6	1.036	-.487	-.045
11.6	1.075	-.464	-.056
19.7	1.035	-.450	-.072
29.5	1.020	-.416	-.059
39.6	1.024	-.379	-.040
49.6	1.010	-.318	-.029
59.7	.989	-.245	-.019
69.7	.970	-.155	-.007
79.8	.950	-.054	-.004
89.7	.954	.051	-.002
89.7	.931	.052	-.003
99.8	.956	.152	0.000
110.1	1.021	.254	.004
120.0	1.064	.351	-.001
130.2	1.104	.451	-.003
140.1	1.118	.531	-.012
150.2	1.126	.582	-.024
160.1	1.135	.617	-.036
170.2	1.150	.632	-.048
180.0	1.119	.619	-.060
189.8	1.105	.609	-.073
199.8	1.116	.585	-.080
209.8	1.158	.554	-.044
219.6	1.058	.500	.059
229.7	.979	.356	.087
239.7	.850	.124	.034
239.7	.849	.132	.034
249.9	.930	.093	.017
259.7	.939	.110	.017
263.8	.975	.104	.009
267.8	.920	.142	.013
271.8	.870	.174	.004
275.8	.832	.183	.024
279.8	.727	.190	.024
283.8	.639	.190	.025
287.8	.532	.186	.037
291.9	.446	.175	.010
295.9	.345	.166	.016
299.9	.275	.132	.006
303.9	.199	.121	.008
308.0	.174	.040	-.009
312.0	0.000	0.000	0.000
316.1	0.000	0.000	0.000
320.0	0.000	0.000	0.000
324.0	.461	-.456	.034
327.9	.609	-.295	.036
331.9	.648	-.276	.051
335.8	.619	-.282	.068
340.0	.624	-.279	.069
343.9	.629	-.296	.058
347.9	.643	-.326	.047
351.7	.695	-.361	.018
355.7	.735	-.469	-.004
360.0	.839	-.567	-.028
363.6	.965	-.501	-.034
367.6	1.036	-.487	-.045

RADIUS = .512

ANGLE	VX/V	VT/V	VR/V
-8.3	.910	-.195	.074
-4.4	.829	-.227	.078
-.4	.757	-.310	.044
3.7	.770	-.395	-.025
7.6	.860	-.431	-.060
11.6	.955	-.415	-.032
15.5	1.009	-.378	.016
19.4	1.031	-.348	.047
29.4	1.021	-.312	.104
39.3	1.008	-.280	.147
49.4	1.003	-.240	.193
59.5	.996	-.190	.227
69.6	.994	-.127	.252
79.5	1.002	-.057	.270
89.6	1.006	.024	.282
99.5	.985	.107	.293
109.6	.979	.190	.290
119.8	.982	.274	.276
130.0	1.001	.352	.245
139.9	1.015	.406	.203
149.8	1.024	.454	.157
159.9	1.039	.492	.100
169.7	1.055	.512	.044
179.6	1.057	.520	-.010
180.0	1.052	.527	-.007
189.7	1.026	.529	-.068
199.7	1.011	.522	-.135
209.8	1.003	.489	-.196
219.7	.995	.448	-.258
229.8	.995	.388	-.318
239.8	1.007	.312	-.349
249.8	.966	.146	-.277
259.7	.991	-.011	-.124
263.7	1.019	-.044	-.075
267.8	1.024	-.025	-.032
269.8	1.038	-.013	-.027
271.7	1.031	.020	-.020
275.7	1.011	.040	-.013
279.8	.953	.068	.014
283.8	.861	.092	.030
287.9	.780	.106	.041
291.9	.639	.088	.026
295.9	.544	.026	.071
296.1	.424	-.021	.111
299.9	.376	-.081	.128
302.1	.388	-.216	.170
304.0	.363	-.286	.218
306.1	.390	-.304	.215
308.1	.369	-.358	.222
310.0	.300	-.296	.223
311.8	0.000	0.000	0.000
312.0	0.000	0.000	0.000
316.0	.333	-.168	.081
320.0	.845	-.453	-.029
323.9	.933	-.417	-.096
327.8	1.010	-.361	-.116
331.8	1.042	-.312	-.107
335.8	1.058	-.287	-.085
339.8	1.069	-.256	-.045
343.9	1.062	-.221	-.004
347.7	1.005	-.198	.034
351.7	.910	-.195	.074

TABLE B-1 CONTINUED

355.6	.829	-.227	.078
359.6	.757	-.310	.044
363.7	.770	-.395	-.025
367.6	.860	-.431	-.060
371.6	.955	-.415	-.032
375.5	1.009	-.378	.016
379.4	1.031	-.348	.047

RADIUS = .711

ANGLE	VX/V	VT/V	VR/V
-4.1	.986	-.219	.001
-.3	.937	-.209	.032
1.5	.887	-.207	.056
3.9	.801	-.225	.075
7.9	.761	-.323	.070
9.5	.790	-.339	.063
11.8	.858	-.406	.040
15.9	.976	-.402	.054
21.4	1.013	-.370	.089
29.9	1.018	-.325	.152
39.8	1.005	-.291	.208
49.8	1.008	-.248	.253
59.8	1.017	-.196	.288
69.8	1.033	-.133	.314
79.7	1.047	-.064	.327
89.9	1.048	.015	.336
99.8	1.022	.085	.341
110.0	1.009	.157	.342
119.9	1.001	.222	.319
130.2	1.000	.281	.283
140.1	.997	.331	.237
150.0	.998	.373	.184
159.9	1.007	.404	124
169.8	1.021	.424	.060
179.7	1.029	.434	-.013
189.7	1.017	.439	-.081
199.7	1.005	.428	-.153
209.7	.994	.407	-.223
219.5	.985	.371	-.288
229.6	.991	.326	-.346
239.6	.979	.281	-.391
249.6	.974	.262	-.379
259.5	1.002	.221	-.274
263.5	1.030	.119	-.218
267.5	1.045	.126	-.223
269.6	1.061	.086	-.223
271.6	1.07[illegible]	.076	-.227
275.5	1.079	.033	-.239
279.7	1.105	-.026	-.247
283.6	1.105	-.071	-.239
287.7	1.101	-.065	-.208
291.8	1.085	-.081	-.161
295.8	1.071	-.086	-.088
299.8	1.060	-.095	-.019
303.9	1.046	-.100	.046
309.0	.984	-.106	.086
310.2	.837	-.197	.109
312.0	.824	-.195	.109
316.0	.843	-.341	.076
319.9	.959	-.363	.033
324.1	1.044	-.298	-.014
328.1	1.053	-.269	-.051
331.9	1.041	-.265	-.063
335.8	1.048	-.266	-.073
340.0	1.051	-.278	-.078
344.0	1.052	-.278	-.072
347.9	1.053	-.276	-.056
351.8	1.033	-.255	-.032

355.9	.986	-.219	.001
359.7	.937	-.209	.032
361.5	.887	-.207	.056
363.9	.801	-.225	.075
367.9	.761	-.323	.070
369.5	.790	-.339	.063

RADIUS = .911

ANGLE	VX/V	VT/V	VR/V
-8.2	1.054	-.228	-.050
-4.2	1.054	-.208	-.030
-.2	1.000	-.186	.009
3.9	.889	-.163	.041
7.9	.780	-.230	.084
11.8	.784	-.336	.095
15.6	.914	-.372	.083
19.7	1.016	-.344	.100
29.6	1.021	-.292	.158
39.6	1.002	-.250	.217
49.6	1.009	-.206	.266
59.6	1.007	-.159	.316
69.7	1.004	-.097	.341
79.7	1.032	-.033	.358
89.8	1.046	.038	.372
99.8	1.042	.113	.369
109.8	1.018	.187	.362
119.9	1.006	.254	.349
130.0	1.001	.316	.311
139.9	.999	.363	.276
149.8	1.000	.404	.224
159.8	.996	.434	.170
163.7	1.011	.445	.144
167.7	1.022	.456	.119
171.7	1.030	.463	.092
175.7	1.032	.466	.068
179.7	1.032	.472	.042
189.5	1.034	.474	-.033
199.5	1.018	.473	-.105
209.5	1.006	.452	-.176
219.4	1.005	.417	-.235
229.6	1.007	.375	-.290
239.7	1.024	.314	-.331
249.7	1.025	.259	-.350
259.8	1.050	.204	-.324
269.9	1.038	.078	-.324
279.9	1.048	-.076	-.304
289.9	1.066	-.135	-.196
290.1	1.043	-.129	-.228
293.9	1.063	-.131	-.154
297.9	1.070	-.121	-.116
300.1	1.042	-.119	-.115
302.1	1.063	-.108	-.080
306.2	1.069	-.084	-.053
310.2	1.074	-.059	-.022
310.3	1.048	-.060	-.020
314.1	1.036	-.014	.034
318.2	.976	.002	.077
320.3	.925	.001	.090
322.2	.909	-.059	.066
326.1	1.028	-.150	-.029
330.2	1.057	-.132	-.071
330.2	1.030	-.137	-.080
340.0	1.046	-.186	-.089
344.1	1.049	-.214	-.073
347.9	1.055	-.225	-.069
350.0	1.057	-.230	-.067
351.8	1.054	-.228	-.050
355.8	1.054	-.208	-.030
359.8	1.000	-.186	.009
363.9	.889	-.163	.041
367.9	.780	-.230	.084
371.8	.784	-.336	.095
375.6	.914	-.372	.083
379.7	1.016	-.344	.100

TABLE B-2 - LISTING OF THE MEAN VELOCITY COMPONENT RATIOS, THE MEAN ADVANCE ANGLES AND OTHER DERIVED QUANTITIES AT THE EXPERIMENTAL AND INTERPOLATED RADII FOR EXPERIMENT 180

RADIUS =	.330	.512	.711	.911	.280	.300	.400	.500	.600	.700	.800	.900	1.000
VXBAR =	.898	.943	1.007	1.016	.888	.892	.914	.940	.978	1.005	1.018	1.017	1.016
VTBAR =	.105	.071	.050	.091	.117	.112	.091	.073	.055	.050	.061	.087	.091
VRBAR =	-.007	.044	.030	.041	-.032	-.021	.020	.042	.035	.030	.032	.040	.041
1-WVX =	.893	.917	.950	.978	0.000	.890	.901	.915	.932	.951	.967	.979	.987
1-WX =	.889	.894	.933	.962	0.000	.892	.884	.895	.914	.936	.954	.965	.971
BBAR =	32.65	24.36	19.50	15.48	36.12	34.65	28.81	24.76	22.08	19.74	17.63	15.68	14.19
BPOS =	19.63	7.46	3.26	2.31	27.91	22.89	13.44	7.90	5.10	3.42	3.10	2.31	1.97
THETA =	10.00	17.50	325.00	22.50	0.00	0.00	12.50	17.50	17.50	325.00	297.50	22.50	22.50
BNEG =	-33.67	-24.84	-2.53	-2.34	-51.27	-43.68	-32.31	-25.89	-11.18	-2.48	-2.89	-2.37	-2.28
THETA =	317.50	312.50	5.00	10.00	320.00	320.00	312.50	312.50	312.50	5.00	7.50	7.50	10.00

VXBAR IS CIRCUMFERENTIAL MEAN LONGITUDINAL VELOCITY.
VTBAR IS CIRCUMFERENTIAL MEAN TANGENTIAL VELOCITY.
VRBAR IS CIRCUMFERENTIAL MEAN RADIAL VELOCITY.
1-WVX IS VOLUMETRIC MEAN WAKE VELOCITY WITHOUT TANGENTIAL CORRECTION.
1-WX IS VOLUMETRIC MEAN WAKE VELOCITY WITH TANGENTIAL CORRECTION.
BBAR IS MEAN ANGLE OF ADVANCE.
BPOS IS VARIATION BETWEEN THE MAXIMUM AND MEAN ADVANCE ANGLES (DELTA BETA PLUS).
BNEG IS VARIATION BETWEEN THE MINIMUM AND MEAN ADVANCE ANGLES (DELTA BETA MINUS).
THETA IS ANGLE IN DEGREES AT WHICH CORRESPONDING BPOS OR BNEG OCCURS.

TABLE B-3 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 180

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .330								
AMPLITUDE =	.2867	.1884	.1346	.0706	.0646	.0445	.0343	.0220
PHASE ANGLE =	311.5	21.9	40.9	90.1	164.2	255.4	324.1	292.9
RADIUS = .512								
AMPLITUDE =	.1231	.0995	.0717	.0847	.0830	.0893	.0772	.0463
PHASE ANGLE =	316.3	20.5	67.0	139.6	198.6	242.2	280.4	318.5
RADIUS = .711								
AMPLITUDE =	.0075	.0266	.0255	.0135	.0213	.0334	.0349	.0203
PHASE ANGLE =	263.7	252.1	271.7	99.5	176.3	212.6	238.0	246.8
RADIUS = .911								
AMPLITUDE =	.0150	.0227	.0184	.0057	.0141	.0171	.0248	.0200
PHASE ANGLE =	210.9	246.7	241.6	137.7	229.2	197.2	197.0	196.5

HARMONIC =	9	10	11	12	13	14	15
RADIUS = .330							
AMPLITUDE =	.0407	.0354	.0265	.0156	.0129	.0143	.0177
PHASE ANGLE =	332.1	8.7	33.8	68.2	91.2	146.9	208.9
RADIUS = .512							
AMPLITUDE =	.0260	.0085	.0047	.0140	.0186	.0195	.0196
PHASE ANGLE =	344.9	3.4	81.1	156.1	197.1	227.4	252.9
RADIUS = .711							
AMPLITUDE =	.0118	.0048	.0072	.0154	.0173	.0159	.0125
PHASE ANGLE =	257.2	232.9	146.2	148.6	167.1	185.8	206.5
RADIUS = .911							
AMPLITUDE =	.0175	.0130	.0091	.0108	.0122	.0138	.0140
PHASE ANGLE =	215.5	204.0	174.8	145.4	124.3	124.9	127.3

TABLE B-4 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 180

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .280								
AMPLITUDE =	.3412	.2099	.1549	.0806	.0619	.0184	.0313	.0168
PHASE ANGLE =	310.3	21.4	32.8	62.0	138.1	283.5	21.9	235.6
RADIUS = .300								
AMPLITUDE =	.3189	.2015	.1464	.0743	.0616	.0289	.0287	.0167
PHASE ANGLE =	310.8	21.6	36.0	73.1	149.6	265.5	356.2	264.2
RADIUS = .400								
AMPLITUDE =	.2173	.1562	.1100	.0774	.0767	.0728	.0580	.0373
PHASE ANGLE =	313.3	22.1	51.9	120.0	185.4	247.5	294.7	314.2
RADIUS = .500								
AMPLITUDE =	.1323	.1059	.0761	.0853	.0837	.0892	.0767	.0464
PHASE ANGLE =	316.0	20.9	65.6	138.5	197.9	242.7	281.5	318.7
RADIUS = .600								
AMPLITUDE =	.0572	.0360	.0191	.0436	.0486	.0581	.0527	.0281
PHASE ANGLE =	314.0	.5	43.8	131.8	191.0	232.4	265.9	295.0
RADIUS = .700								
AMPLITUDE =	.0100	.0242	.0231	.0153	.0233	.0351	.0360	.0204
PHASE ANGLE =	282.2	257.6	274.5	105.2	177.9	214.9	241.1	251.5
RADIUS = .800								
AMPLITUDE =	.0160	.0378	.0344	.0070	.0103	.0235	.0294	.0213
PHASE ANGLE =	172.5	236.1	260.5	46.2	174.6	195.4	214.6	217.5
RADIUS = .900								
AMPLITUDE =	.0153	.0256	.0212	.0043	.0125	.0175	.0254	.0204
PHASE ANGLE =	201.7	243.0	245.8	124.7	225.9	194.9	198.0	198.3
RADIUS = 1.000								
AMPLITUDE =	.0150	.0227	.0184	.0057	.0141	.0171	.0248	.0200
PHASE ANGLE =	210.9	246.7	241.6	137.7	229.2	197.2	197.0	196.5

TABLE B-4 CONTINUED

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	9	10	11	12	13	14	15
RADIUS = .280							
AMPLITUDE =	.0444	.0455	.0359	.0234	.0237	.0229	.0207
PHASE ANGLE =	325.5	8.6	32.1	53.3	71.3	121.2	185.7
RADIUS = .300							
AMPLITUDE =	.0429	.0413	.0319	.0200	.0189	.0188	.0191
PHASE ANGLE =	328.2	8.7	32.6	58.1	76.8	129.2	194.7
RADIUS = .400							
AMPLITUDE =	.0357	.0232	.0156	.0104	.0095	.0132	.0180
PHASE ANGLE =	339.6	8.4	38.9	109.0	162.7	200.3	236.0
RADIUS = .500							
AMPLITUDE =	.0272	.0098	.0053	.0135	.0179	.0191	.0196
PHASE ANGLE =	344.9	4.6	71.5	153.9	196.3	226.7	252.3
RADIUS = .600							
AMPLITUDE =	.0145	.0036	.0054	.0153	.0185	.0179	.0161
PHASE ANGLE =	318.5	330.8	120.0	151.8	183.0	209.2	235.6
RADIUS = .700							
AMPLITUDE =	.0115	.0043	.0071	.0154	.0174	.0161	.0128
PHASE ANGLE =	262.5	237.6	144.3	148.8	168.7	188.3	209.9
RADIUS = .800							
AMPLITUDE =	.0153	.0087	.0084	.0141	.0152	.0142	.0111
PHASE ANGLE =	230.0	213.8	159.6	146.9	152.6	163.1	172.5
RADIUS = .900							
AMPLITUDE =	.0175	.0126	.0091	.0113	.0124	.0137	.0135
PHASE ANGLE =	216.6	204.7	173.3	145.5	127.9	129.1	131.1
RADIUS = 1.000							
AMPLITUDE =	.0175	.0130	.0091	.0108	.0122	.0138	.0140
PHASE ANGLE =	215.5	204.0	174.8	145.4	124.3	124.9	127.3

TABLE B-5 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 180

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .330								
AMPLITUDE =	.4975	.1084	.0723	.0506	.0328	.0209	.0024	.0168
PHASE ANGLE =	263.5	180.5	261.8	341.3	88.6	207.5	263.7	170.4
RADIUS = .512								
AMPLITUDE =	.4365	.0335	.0112	.0193	.0383	.0470	.0371	.0125
PHASE ANGLE =	267.7	112.4	201.0	358.5	99.5	159.7	212.5	261.6
RADIUS = .711								
AMPLITUDE =	.3935	.0053	.0225	.0193	.0115	.0152	.0236	.0171
PHASE ANGLE =	264.3	102.1	93.2	121.8	135.9	106.2	132.6	175.2
RADIUS = .911								
AMPLITUDE =	.3735	.0362	.0413	.0291	.0169	.0161	.0222	.0189
PHASE ANGLE =	264.0	118.8	151.3	207.1	263.7	10.3	69.9	107.8

HARMONIC =	9	10	11	12	13	14	15
RADIUS = .330							
AMPLITUDE =	.0207	.0131	.0134	.0173	.0110	.0060	.0064
PHASE ANGLE =	232.5	256.4	249.0	283.6	327.8	326.6	343.9
RADIUS = .512							
AMPLITUDE =	.0105	.0197	.0171	.0119	.0078	.0075	.0119
PHASE ANGLE =	130.8	178.2	209.8	244.0	282.5	2.7	65.8
RADIUS = .711							
AMPLITUDE =	.0045	.0076	.0107	.0133	.0147	.0114	.0055
PHASE ANGLE =	245.1	26.8	56.1	63.7	83.7	114.3	144.7
RADIUS = .911							
AMPLITUDE =	.0103	.0067	.0070	.0031	.0058	.0088	.0093
PHASE ANGLE =	119.8	91.2	81.8	70.4	13.3	26.6	37.8

TABLE B-6 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 180

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .280								
AMPLITUDE =	.5189	.1500	.0978	.0598	.0263	.0214	.0193	.0280
PHASE ANGLE =	261.4	187.3	264.8	339.9	82.1	266.8	35.0	155.5
RADIUS = .300								
AMPLITUDE =	.5101	.1324	.0872	.0561	.0292	.0186	.0104	.0231
PHASE ANGLE =	262.3	184.9	263.8	340.4	85.2	242.2	30.2	160.1
RADIUS = .400								
AMPLITUDE =	.4712	.0645	.0422	.0381	.0384	.0355	.0229	.0098
PHASE ANGLE =	265.7	164.2	254.5	344.6	93.8	174.5	220.9	218.8
RADIUS = .500								
AMPLITUDE =	.4398	.0347	.0129	.0212	.0389	.0468	.0367	.0123
PHASE ANGLE =	267.6	118.6	214.0	355.8	98.9	160.8	213.6	260.9
RADIUS = .600								
AMPLITUDE =	.4145	.0138	.0113	.0135	.0254	.0293	.0255	.0135
PHASE ANGLE =	265.9	107.7	94.9	70.2	108.9	145.1	178.4	209.1
RADIUS = .700								
AMPLITUDE =	.3953	.0054	.0218	.0189	.0127	.0161	.0235	.0169
PHASE ANGLE =	264.4	101.1	91.6	118.1	131.3	111.7	136.5	177.9
RADIUS = .800								
AMPLITUDE =	.3818	.0116	.0274	.0209	.0074	.0128	.0240	.0175
PHASE ANGLE =	263.7	115.0	114.5	154.6	209.4	56.0	105.6	151.1
RADIUS = .900								
AMPLITUDE =	.3740	.0329	.0391	.0275	.0157	.0157	.0224	.0184
PHASE ANGLE =	263.9	118.7	148.0	202.3	261.2	13.9	74.1	112.6
RADIUS = 1.000								
AMPLITUDE =	.3735	.0362	.0413	.0291	.0169	.0161	.0222	.0189
PHASE ANGLE =	264.0	118.8	151.3	207.1	263.7	10.3	69.9	107.8

TABLE B-6 CONTINUED

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	9	10	11	12	13	14	15
RADIUS = .280							
AMPLITUDE =	.0323	.0200	.0119	.0189	.0128	.0040	.0101
PHASE ANGLE =	243.7	294.5	283.8	301.5	352.4	301.7	301.9
RADIUS = .300							
AMPLITUDE =	.0273	.0163	.0121	.0181	.0118	.0048	.0081
PHASE ANGLE =	240.0	282.0	267.8	294.1	342.5	314.8	315.3
RADIUS = .400							
AMPLITUDE =	.0107	.0154	.0171	.0162	.0106	.0079	.0084
PHASE ANGLE =	196.5	204.4	225.8	264.0	301.5	341.4	39.2
RADIUS = .500							
AMPLITUDE =	.0103	.0198	.0176	.0126	.0084	.0077	.0118
PHASE ANGLE =	134.3	179.8	211.2	245.8	283.6	359.6	64.0
RADIUS = .600							
AMPLITUDE =	.0037	.0043	.0029	.0036	.0066	.0069	.0065
PHASE ANGLE =	186.8	155.1	147.0	62.7	80.1	97.9	106.6
RADIUS = .700							
AMPLITUDE =	.0045	.0070	.0101	.0128	.0143	.0113	.0056
PHASE ANGLE =	244.3	27.8	56.9	63.7	84.0	114.4	143.5
RADIUS = .800							
AMPLITUDE =	.0027	.0092	.0126	.0131	.0134	.0098	.0036
PHASE ANGLE =	210.9	31.5	56.2	64.3	77.5	102.8	121.2
RADIUS = .900							
AMPLITUDE =	.0089	.0066	.0078	.0045	.0061	.0080	.0081
PHASE ANGLE =	122.0	80.3	75.5	67.9	29.2	35.9	40.8
RADIUS = 1.000							
AMPLITUDE =	.0103	.0067	.0070	.0031	.0058	.0088	.0093
PHASE ANGLE =	119.8	91.2	81.8	70.4	13.3	26.6	37.8

TABLE B-7

INPUT DATA FOR HARMONIC ANALYSIS FOR FF 1088,
MODEL 4989, EXPERIMENT 181

INPUT DATA

RADIUS = .330

ANGLE	VX/V	VT/V	VR/V
-.7	.756	-.312	.031
-.7	.748	-.318	.039
3.3	.793	-.349	.031
7.4	.900	-.347	.015
9.3	.941	-.355	.002
11.3	.974	-.350	-.002
15.2	1.028	-.330	-.011
19.2	1.057	-.313	-.027
23.3	1.066	-.292	-.034
29.2	1.058	-.265	-.045
39.2	1.037	-.245	-.045
49.2	1.014	-.202	-.038
59.2	1.011	-.158	-.031
69.3	.994	-.090	-.024
79.4	.990	-.025	-.021
89.4	.988	.051	-.021
99.2	.999	.117	-.021
109.3	1.022	.186	-.018
119.2	1.053	.255	-.013
129.1	1.094	.320	-.011
139.3	1.118	.394	-.016
149.4	1.126	.445	-.018
159.4	1.136	.491	-.025
169.2	1.127	.521	-.032
179.2	1.135	.539	-.040
189.0	1.135	.534	-.045
199.0	1.143	.521	-.044
209.0	1.152	.490	-.039
219.0	1.188	.441	-.008
223.0	1.214	.414	.019
227.0	1.226	.398	.052
228.9	1.215	.394	.065
231.0	1.199	.378	.084
235.0	1.138	.343	.123
239.0	1.099	.288	.133
243.1	1.062	.248	.114
247.0	1.013	.220	.077
249.1	.966	.191	.051
251.1	.954	.155	.046
255.0	.941	.080	.026
259.1	.952	.056	.014
263.0	.980	.066	.020
267.0	.973	.096	.020
271.0	.962	.131	.021
274.9	.942	.161	.032
278.9	.878	.176	.029
282.9	.812	.176	.035
286.9	.693	.152	.040
290.9	.579	.084	.051
295.0	.507	.008	.047
299.1	.471	-.100	.060
303.0	.453	-.169	.087
307.0	.448	-.174	.115
311.0	.466	-.192	.149
315.1	.498	-.162	.130
319.2	.546	-.179	.107
323.3	.583	-.228	.099
327.3	.672	-.247	.089
331.4	.719	-.238	.096
335.4	.756	-.227	.087
339.4	.735	-.219	.079
343.4	.727	-.222	.079
347.4	.715	-.232	.072
351.4	.694	-.261	.062
355.4	.703	-.292	.055
359.3	.756	-.312	.031
359.5	.764	-.313	.029
363.3	.793	-.349	.031
367.4	.900	-.347	.015
369.3	.941	-.355	.002
371.3	.974	-.350	-.002
375.2	1.028	-.330	-.011

RADIUS = .512

ANGLE	VX/V	VT/V	VR/V
-16.4	1.042	-.145	-.041
-12.4	1.051	-.144	-.021
-8.5	1.040	-.131	.009
-4.5	1.037	-.101	.042
-.3	.959	-.076	.072
3.5	.845	-.095	.089
7.5	.786	-.168	.077
11.4	.810	-.291	.041
15.4	.937	-.302	.025
19.4	1.019	-.260	.030
29.4	1.030	-.202	.070
39.3	1.010	-.181	.102
49.3	1.011	-.157	.134
59.3	.997	-.124	.155
69.2	1.001	-.083	.183
79.4	.999	-.034	.201
89.4	1.024	.019	.208
99.2	.994	.074	.220
109.2	.994	.128	.223
119.3	1.002	.184	.213
129.3	1.020	.240	.197
139.3	1.025	.295	.175
149.3	1.039	.339	.142
159.5	1.058	.364	.103
169.4	1.065	.391	.065
179.4	1.058	.405	.027
189.2	1.061	.413	-.017
219.0	1.024	.367	-.155
229.1	1.027	.324	-.200
239.2	1.020	.269	-.229
249.3	1.016	.219	-.215
259.3	1.010	.100	-.108
263.4	1.010	.070	-.079
267.4	1.026	.042	-.070
269.3	1.010	.035	-.085
271.3	1.006	.024	-.086
275.2	.970	-.007	-.107
279.3	.959	-.023	-.126
283.3	.967	-.029	-.128
287.2	.965	-.019	-.082
289.3	.970	.008	-.073
291.4	.941	.006	-.050
295.3	.868	.008	-.012
299.4	.812	-.004	.027
303.4	.761	-.060	.097
307.5	.778	-.099	.144
311.6	.778	-.104	.166
315.5	.768	-.156	.126
319.6	.830	-.226	.068
323.6	.922	-.229	.021
327.5	1.004	-.194	-.026
331.7	1.029	-.167	-.048
335.7	1.032	-.149	-.055
339.7	1.039	-.146	-.051
343.6	1.042	-.145	-.041
347.6	1.051	-.144	-.021
351.5	1.040	-.131	.009
355.5	1.037	-.101	.042
359.7	.959	-.076	.072
363.5	.845	-.095	.089
367.5	.786	-.168	.077

TABLE B-7 CONTINUED

371.4	.810	-.291	.041
375.4	.937	-.302	.025
379.4	1.019	-.260	.030

RADIUS = .711

ANGLE	VX/V	VT/V	VR/V
-4.8	1.036	-.164	-.044
-.6	1.035	-.158	-.027
3.0	1.036	-.120	.003
7.0	.965	-.079	.040
9.5	.884	-.085	.058
11.1	.836	-.129	.061
15.0	.822	-.248	.057
19.4	.952	-.287	.062
22.9	1.020	-.247	.076
26.8	1.024	-.217	.085
29.2	1.008	-.208	.094
39.3	1.003	-.193	.131
49.3	1.005	-.169	.162
59.3	1.002	-.136	.195
69.5	1.008	-.103	.228
79.3	1.019	-.054	.247
89.3	1.025	-.003	.261
99.2	1.008	.044	.263
109.3	.998	.092	.267
119.2	.987	.140	.263
129.3	.982	.189	.251
139.3	.988	.233	.219
149.4	.993	.268	.181
159.3	1.009	.293	.142
169.4	1.012	.312	.092
179.3	1.029	.325	.043
189.2	1.019	.330	-.013
199.0	1.017	.330	-.070
209.1	1.005	.321	-.126
219.0	.988	.302	-.181
229.1	.991	.269	-.240
239.1	.990	.221	-.293
249.1	.998	.164	-.325
255.1	.977	.105	-.318
259.0	1.003	.061	-.281
263.0	1.016	.014	-.269
267.0	1.021	-.023	-.253
271.1	1.022	-.071	-.255
274.9	1.019	-.092	-.247
278.9	1.006	-.112	-.238
282.9	.995	-.139	-.205
287.0	.995	-.153	-.175
290.9	1.002	-.168	-.138
294.9	1.006	-.167	-.089
299.0	1.029	-.162	-.048
303.0	1.032	-.149	.001
307.0	1.038	-.138	.040
311.0	1.036	-.116	.071
315.1	1.042	-.065	.109
319.2	.933	-.010	.165
323.3	.802	-.103	.114
327.3	.933	-.170	-.012
331.3	.968	-.125	-.070
335.3	.985	-.127	-.085
339.2	1.014	-.141	-.086
343.3	1.016	-.152	-.082
347.2	1.029	-.155	-.074
351.2	1.035	-.160	-.057
355.2	1.036	-.164	-.044
359.4	1.035	-.158	-.027
363.0	1.036	-.120	.003
367.0	.965	-.079	.040
369.5	.884	-.085	.058
371.1	.836	-.129	.061
375.0	.822	-.248	.057

RADIUS = .911

ANGLE	VX/V	VT/V	VR/V
-40.3	1.048	-.028	.149
-30.4	1.047	-.028	-.038
-20.2	.979	-.042	-.065
-10.3	.994	-.116	-.070
-.4	1.035	-.139	-.030
9.4	.948	-.061	.045
19.3	.934	-.247	.076
29.3	.994	-.174	.109
39.4	1.003	-.162	.145
49.4	.995	-.143	.186
59.4	.992	-.116	.224
69.4	1.002	-.080	.250
79.4	1.010	-.039	.278
89.4	1.035	.005	.289
99.3	1.030	.048	.302
109.3	1.018	.097	.302
119.4	.994	.153	.297
129.3	1.000	.200	.286
139.4	.993	.249	.250
149.5	.999	.287	.216
159.4	1.009	.314	.167
169.6	1.017	.339	.121
179.5	1.032	.348	.070
189.3	1.049	.358	.021
199.2	1.039	.361	-.027
209.1	1.023	.357	-.082
219.1	1.019	.344	-.143
229.2	.999	.319	-.200
239.3	.997	.287	-.266
249.2	.991	.251	-.327
259.3	.996	.170	-.317
269.3	1.001	.049	-.291
279.3	.996	-.115	-.245
289.4	1.056	-.192	-.163
299.3	1.076	-.195	-.009
309.4	1.044	-.128	.100
319.7	1.048	-.028	.149
329.6	1.047	-.028	-.038
339.8	.979	-.042	-.065
349.7	.994	-.116	-.070
359.6	1.035	-.139	-.030
369.4	.948	-.061	.045
379.3	.934	-.247	.076
389.3	.994	-.174	.109
399.4	1.003	-.162	.145
409.4	.995	-.143	.186

RADIUS = 1.082

ANGLE	VX/V	VT/V	VR/V
0.0	.959	-.195	-.088
1.0	.982	-.197	-.084
9.1	1.026	-.149	-.010
14.8	.803	-.165	.054
18.8	.831	-.280	.096
19.2	.838	-.279	.110
19.6	.895	-.293	.112
24.7	.985	-.245	.074
29.1	.993	-.220	.089
39.1	.997	-.217	.141
49.1	1.001	-.194	.175
59.1	1.008	-.166	.222
69.2	1.008	-.132	.260
79.3	1.020	-.096	.277
89.1	1.035	-.051	.292
98.7	1.027	-.005	.304
109.1	1.024	.037	.304
119.2	1.017	.088	.309
119.7	1.006	.106	.296
129.4	1.013	.129	.291
139.4	1.017	.182	.260

TABLE B-7 CONTINUED

149.6	1.021	.214	.229
159.6	1.029	.245	.186
169.6	1.038	.260	.136
179.5	1.052	.276	.079
189.3	1.053	.276	.029
199.4	1.056	.288	-.027
209.4	1.045	.287	-.083
219.3	1.029	.280	-.145
229.4	1.016	.262	-.208
238.6	1.001	.247	-.275
249.4	.999	.211	-.343
258.8	.984	.187	-.396
265.0	.975	.170	-.412
269.3	.971	.082	-.393
274.8	1.006	-.014	-.393
278.6	1.004	-.092	-.383
284.7	.997	-.149	-.373
289.2	.965	-.226	-.320
294.8	.953	-.309	-.190
299.4	1.000	-.322	-.060
304.8	.996	-.281	.081
309.4	1.014	-.241	.143
315.0	1.042	-.169	.188
319.5	1.048	-.108	.191
320.1	1.035	-.088	.176
325.0	.928	.017	.101
330.0	.980	-.059	-.059
335.1	.971	-.035	-.113
340.1	.936	-.040	-.131
345.0	.921	-.066	-.126
349.5	.930	-.110	-.127
355.0	.935	-.172	-.119
360.0	.959	-.195	-.088
369.5	.967	-.141	-.005

TABLE B-8 - LISTING OF THE MEAN VELOCITY COMPONENT RATIOS, THE MEAN ADVANCE ANGLES AND OTHER DERIVED QUANTITIES AT THE EXPERIMENTAL AND INTERPOLATED RADII FOR EXPERIMENT 181

RADIUS =	.330	.512	.711	.911	1.082	.280	.300	.400	.500	.600	.700	.800	.900	1.000
VXBAR =	.961	.994	.998	1.011	1.004	.946	.952	.977	.993	.995	.998	1.007	1.011	1.010
VTBAR =	.097	.078	.038	.070	.021	.099	.098	.091	.079	.052	.039	.064	.071	.053
VRBAR =	.011	.038	.026	.045	.027	-.003	.003	.026	.038	.029	.026	.039	.045	.040
1-WVX =	.954	.976	.988	.995	.999	0.000	.950	.963	.975	.983	.987	.991	.995	.998
1-WX =	.906	.934	.960	.974	.981	0.000	.901	.916	.933	.948	.959	.968	.973	.978
BBAR =	34.60	25.45	19.43	15.49	13.24	38.30	36.73	30.44	25.92	22.45	19.69	17.43	15.66	14.23
BPOS =	12.45	5.02	2.44	2.18	2.35	16.82	14.55	8.65	5.30	3.70	2.55	2.30	2.22	1.68
THETA =	20.00	22.50	25.00	297.50	5.00	10.00	20.00	20.00	22.50	22.50	25.00	297.50	297.50	300.00
BNEG =	-13.35	-4.07	-2.68	-1.11	-2.55	-19.62	-16.83	-8.87	-4.52	-2.00	-2.73	-1.37	-1.14	-1.11
THETA =	295.00	302.50	322.50	230.00	17.50	295.00	295.00	302.50	302.50	217.50	322.50	227.50	230.00	17.50

VXBAR IS CIRCUMFERENTIAL MEAN LONGITUDINAL VELOCITY.
VTBAR IS CIRCUMFERENTIAL MEAN TANGENTIAL VELOCITY.
VRBAR IS CIRCUMFERENTIAL MEAN RADIAL VELOCITY.
1-WVX IS VOLUMETRIC MEAN WAKE VELOCITY WITHOUT TANGENTIAL CORRECTION.
1-WX IS VOLUMETRIC MEAN WAKE VELOCITY WITH TANGENTIAL CORRECTION.
BBAR IS MEAN ANGLE OF ADVANCE.
BPOS IS VARIATION BETWEEN THE MAXIMUM AND MEAN ADVANCE ANGLES (DELTA BETA PLUS).
BNEG IS VARIATION BETWEEN THE MINIMUM AND MEAN ADVANCE ANGLES (DELTA BETA MINUS).
THETA IS ANGLE IN DEGREES AT WHICH CORRESPONDING BPOS OR BNEG OCCURS.

TABLE B-9 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 181

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .330								
AMPLITUDE =	.2212	.1472	.0746	.0062	.0174	.0435	.0481	.0226
PHASE ANGLE =	299.4	13.6	47.5	153.6	195.1	255.2	304.5	2.6
RADIUS = .512								
AMPLITUDE =	.0569	.0354	.0153	.0324	.0348	.0380	.0319	.0170
PHASE ANGLE =	297.4	28.7	67.1	149.9	197.6	224.0	239.0	249.3
RADIUS = .711								
AMPLITUDE =	.0097	.0070	.0134	.0112	.0072	.0136	.0200	.0204
PHASE ANGLE =	274.2	284.5	257.8	99.0	144.0	152.3	158.4	164.9
RADIUS = .911								
AMPLITUDE =	.0120	.0137	.0260	.0069	.0036	.0041	.0103	.0055
PHASE ANGLE =	214.1	196.7	227.5	394.4	312.7	137.9	146.5	114.2
RADIUS = 1.082								
AMPLITUDE =	.0351	.0037	.0189	.0044	.0034	.0032	.0094	.0134
PHASE ANGLE =	284.7	316.6	232.6	329.2	313.6	39.9	86.5	85.0

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .330								
AMPLITUDE =	.0052	.0138	.0076	.0049	.0026	.0017	.0024	.0027
PHASE ANGLE =	229.0	284.0	326.4	332.3	26.8	133.0	228.9	191.5
RADIUS = .512								
AMPLITUDE =	.0054	.0071	.0156	.0156	.0115	.0085	.0106	.0103
PHASE ANGLE =	244.0	183.6	155.0	184.7	168.1	157.4	142.3	147.8
RADIUS = .711								
AMPLITUDE =	.0173	.0099	.0005	.0087	.0111	.0133	.0129	.0117
PHASE ANGLE =	182.5	209.7	2.8	74.7	74.6	73.3	80.4	90.4
RADIUS = .911								
AMPLITUDE =	.0041	.0082	.0106	.0065	.0043	.0006	.0014	.0017
PHASE ANGLE =	84.8	77.0	98.7	105.4	138.8	80.9	87.5	127.9
RADIUS = 1.082								
AMPLITUDE =	.0129	.0093	.0063	.0123	.0163	.0139	.0114	.0122
PHASE ANGLE =	96.2	105.3	57.7	37.1	41.2	41.7	24.4	19.1

TABLE B-10 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 181

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .280								
AMPLITUDE =	.2864	.1920	.0973	.0093	.0053	.0440	.0610	.0352
PHASE ANGLE =	299.5	11.7	45.1	334.5	176.0	267.9	319.3	19.6
RADIUS = .300								
AMPLITUDE =	.2593	.1733	.0879	.0026	.0104	.0437	.0553	.0297
PHASE ANGLE =	299.5	12.4	46.0	334.7	189.7	262.6	313.9	14.0
RADIUS = .400								
AMPLITUDE =	.1444	.0947	.0475	.0219	.0292	.0430	.0375	.0137
PHASE ANGLE =	299.1	17.4	52.1	152.7	198.0	241.1	278.8	315.6
RADIUS = .500								
AMPLITUDE =	.0642	.0403	.0181	.0321	.0350	.0388	.0323	.0165
PHASE ANGLE =	297.8	26.9	64.4	150.3	197.8	225.7	242.7	253.9
RADIUS = .600								
AMPLITUDE =	.0307	.0166	.0029	.0205	.0188	.0211	.0203	.0164
PHASE ANGLE =	295.2	11.0	349.9	134.0	184.1	200.7	201.7	193.7
RADIUS = .700								
AMPLITUDE =	.0111	.0069	.0123	.0118	.0079	.0138	.0198	.0203
PHASE ANGLE =	278.9	295.9	259.8	103.4	149.8	156.8	161.3	166.6
RADIUS = .800								
AMPLITUDE =	.0092	.0107	.0212	.0058	.0011	.0088	.0153	.0108
PHASE ANGLE =	204.0	210.0	234.5	90.4	167.6	150.5	157.8	159.3
RADIUS = .900								
AMPLITUDE =	.0118	.0138	.0259	.0068	.0033	.0045	.0107	.0055
PHASE ANGLE =	209.9	197.1	227.7	357.4	312.0	140.4	148.6	120.9
RADIUS = 1.000								
AMPLITUDE =	.0178	.0087	.0245	.0069	.0045	.0021	.0080	.0084
PHASE ANGLE =	259.2	200.8	227.5	339.1	314.7	87.8	119.0	84.1

TABLE B-10 CONTINUED

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .280								
AMPLITUDE =	.0068	.0212	.0202	.0162	.0107	.0040	.0054	.0026
PHASE ANGLE =	205.3	291.4	330.5	344.0	10.5	26.6	303.9	301.1
RADIUS = .300								
AMPLITUDE =	.0060	.0181	.0148	.0114	.0072	.0022	.0036	.0016
PHASE ANGLE =	214.2	289.1	329.6	341.6	12.7	44.4	287.0	257.0
RADIUS = .400								
AMPLITUDE =	.0050	.0067	.0057	.0071	.0059	.0058	.0063	.0068
PHASE ANGLE =	254.3	255.2	168.9	176.3	171.1	167.5	164.6	164.4
RADIUS = .500								
AMPLITUDE =	.0053	.0068	.0152	.0153	.0113	.0084	.0103	.0101
PHASE ANGLE =	247.9	186.8	155.1	165.7	169.3	159.7	144.5	149.6
RADIUS = .600								
AMPLITUDE =	.0133	.0103	.0058	.0083	.0084	.0101	.0116	.0109
PHASE ANGLE =	193.6	206.2	164.1	124.8	107.0	94.4	100.7	109.9
RADIUS = .700								
AMPLITUDE =	.0173	.0102	.0001	.0086	.0110	.0133	.0130	.0117
PHASE ANGLE =	183.3	210.0	333.7	77.2	75.8	74.3	81.6	91.5
RADIUS = .800								
AMPLITUDE =	.0068	.0030	.0070	.0072	.0058	.0044	.0057	.0059
PHASE ANGLE =	174.1	128.8	102.3	104.7	121.8	89.1	96.6	116.2
RADIUS = .900								
AMPLITUDE =	.0037	.0078	.0105	.0066	.0046	.0006	.0016	.0021
PHASE ANGLE =	90.7	77.4	99.4	107.7	142.1	103.0	97.8	133.2
RADIUS = 1.000								
AMPLITUDE =	.0082	.0097	.0094	.0070	.0058	.0048	.0043	.0042
PHASE ANGLE =	80.3	83.4	88.7	68.5	65.5	36.7	21.9	19.1

TABLE B-11 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 181

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .330								
AMPLITUDE =	.4117	.0232	.0213	.0164	.0245	.0328	.0269	.0135
PHASE ANGLE =	265.3	130.9	261.4	22.4	116.7	193.8	255.1	341.0
RADIUS = .512								
AMPLITUDE =	.3095	.0371	.0189	.0038	.0175	.0241	.0244	.0119
PHASE ANGLE =	264.3	85.1	140.0	148.4	90.5	123.7	155.7	182.2
RADIUS = .711								
AMPLITUDE =	.2666	.0516	.0426	.0231	.0097	.0117	.0127	.0113
PHASE ANGLE =	267.0	84.7	141.5	210.5	314.2	33.7	74.4	74.4
RADIUS = .911								
AMPLITUDE =	.2656	.0592	.0560	.0445	.0242	.0171	.0132	.0082
PHASE ANGLE =	263.3	72.5	127.0	190.1	253.6	332.6	39.4	67.6
RADIUS = 1.082								
AMPLITUDE =	.2537	.0501	.0636	.0575	.0404	.0278	.0178	.0097
PHASE ANGLE =	260.0	63.1	113.0	171.6	225.5	285.4	352.3	37.0

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .330								
AMPLITUDE =	.0114	.0139	.0097	.0054	.0038	.0037	.0042	.0051
PHASE ANGLE =	97.9	171.4	226.3	258.1	295.6	330.0	26.5	76.5
RADIUS = .512								
AMPLITUDE =	.0019	.0073	.0089	.0105	.0093	.0064	.0084	.0078
PHASE ANGLE =	148.0	76.7	70.4	75.2	80.7	71.6	57.0	76.9
RADIUS = .711								
AMPLITUDE =	.0102	.0070	.0017	.0064	.0094	.0100	.0099	.0077
PHASE ANGLE =	73.5	88.3	38.0	345.9	351.5	350.5	352.0	.7
RADIUS = .911								
AMPLITUDE =	.0068	.0081	.0071	.0061	.0074	.0082	.0073	.0051
PHASE ANGLE =	36.2	26.1	19.9	.3	342.0	330.3	337.7	327.6
RADIUS = 1.082								
AMPLITUDE =	.0046	.0047	.0030	.0024	.0090	.0084	.0045	.0071
PHASE ANGLE =	37.7	20.3	27.8	282.3	302.2	316.9	308.7	280.3

TABLE B-12 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 181

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .280								
AMPLITUDE =	.4504	.0256	.0335	.0216	.0250	.0428	.0418	.0263
PHASE ANGLE =	265.9	154.2	268.2	16.2	126.2	211.3	275.1	350.4
RADIUS = .300								
AMPLITUDE =	.4344	.0241	.0284	.0195	.0248	.0383	.0351	.0208
PHASE ANGLE =	265.6	145.1	266.3	18.5	122.2	204.9	268.6	347.7
RADIUS = .400								
AMPLITUDE =	.3653	.0265	.0091	.0095	.0231	.0262	.0191	.0038
PHASE ANGLE =	264.6	103.5	221.4	35.8	105.9	163.5	205.8	253.2
RADIUS = .500								
AMPLITUDE =	.3144	.0360	.0171	.0033	.0183	.0243	.0239	.0115
PHASE ANGLE =	264.2	86.0	142.2	130.3	92.3	127.2	158.8	184.5
RADIUS = .600								
AMPLITUDE =	.2853	.0445	.0309	.0115	.0078	.0142	.0145	.0073
PHASE ANGLE =	266.2	86.8	144.3	212.6	46.4	93.9	126.1	118.5
RADIUS = .700								
AMPLITUDE =	.2679	.0510	.0416	.0220	.0090	.0115	.0125	.0110
PHASE ANGLE =	267.0	85.1	142.0	211.3	319.9	39.2	78.5	76.3
RADIUS = .800								
AMPLITUDE =	.2679	.0573	.0494	.0339	.0156	.0141	.0132	.0096
PHASE ANGLE =	265.4	78.4	135.0	280.7	278.2	4.7	62.1	75.6
RADIUS = .900								
AMPLITUDE =	.2661	.0593	.0554	.0436	.0233	.0167	.0132	.0083
PHASE ANGLE =	263.5	73.0	127.8	191.2	255.7	335.8	42.1	69.0
RADIUS = 1.000								
AMPLITUDE =	.2607	.0563	.0602	.0515	.0319	.0211	.0144	.0082
PHASE ANGLE =	261.6	68.0	120.1	180.9	238.1	306.5	14.7	52.6

TABLE B-12 CONTINUED

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .280								
AMPLITUDE =	.0171	.0208	.0186	.0141	.0110	.0082	.0046	.0032
PHASE ANGLE =	92.9	180.4	233.0	260.8	285.2	306.9	338.8	55.3
RADIUS = .300								
AMPLITUDE =	.0147	.0178	.0148	.0104	.0079	.0051	.0040	.0040
PHASE ANGLE =	94.6	177.4	231.1	260.0	287.1	312.5	358.2	67.2
RADIUS = .400								
AMPLITUDE =	.0056	.0075	.0022	.0036	.0048	.0034	.0064	.0071
PHASE ANGLE =	111.4	142.3	140.3	83.4	79.1	58.3	55.7	82.9
RADIUS = .500								
AMPLITUDE =	.0021	.0070	.0084	.0102	.0091	.0063	.0083	.0079
PHASE ANGLE =	146.5	80.5	71.5	76.1	81.8	72.8	58.2	78.3
RADIUS = .600								
AMPLITUDE =	.0067	.0074	.0043	.0057	.0070	.0071	.0083	.0066
PHASE ANGLE =	84.7	90.2	71.0	35.7	28.4	16.5	17.2	34.0
RADIUS = .700								
AMPLITUDE =	.0100	.0071	.0018	.0062	.0092	.0098	.0098	.0076
PHASE ANGLE =	74.4	89.5	44.4	348.4	353.4	352.0	353.6	2.9
RADIUS = .800								
AMPLITUDE =	.0081	.0071	.0054	.0070	.0084	.0089	.0089	.0062
PHASE ANGLE =	54.7	48.2	21.8	357.8	352.6	341.7	346.6	352.0
RADIUS = .900								
AMPLITUDE =	.0069	.0081	.0071	.0063	.0075	.0082	.0074	.0051
PHASE ANGLE =	37.5	27.4	19.9	.6	343.8	331.4	338.8	330.8
RADIUS = 1.000								
AMPLITUDE =	.0058	.0072	.0060	.0039	.0075	.0081	.0058	.0055
PHASE ANGLE =	30.7	19.7	21.0	348.8	322.5	322.4	326.5	300.1

TABLE B-13

INPUT DATA FOR HARMONIC ANALYSIS FOR FF 1088,
MODEL 4989, EXPERIMENT 182

INPUT DATA

RADIUS = .330

ANGLE	VX/V	VT/V	VR/V
-.4	.915	-.502	-.034
5.0	.965	-.527	-.051
10.7	.999	-.513	-.065
14.8	.994	-.492	-.067
24.7	.992	-.470	-.049
34.7	.975	-.440	-.039
44.7	.979	-.380	-.021
54.8	.965	-.305	-.008
58.9	.969	-.273	-.003
64.8	.957	-.211	-0.000
75.0	.948	-.091	.011
78.9	.934	-.046	.011
84.9	.944	.031	.006
94.9	.958	.139	.008
99.0	.979	.185	.013
105.0	1.012	.250	.010
109.5	1.032	.307	.015
114.9	1.060	.347	.012
119.2	1.077	.392	.014
125.2	1.098	.454	.010
135.1	1.115	.545	.004
139.2	1.140	.567	.006
145.0	1.128	.612	-.001
149.5	1.091	.641	-.004
154.9	1.154	.650	-.008
158.9	1.153	.659	-.008
164.8	1.148	.675	-.020
175.0	1.112	.696	-.038
179.0	1.108	.693	-.040
189.3	1.087	.719	-.051
198.7	1.064	.693	-.066
204.7	1.105	.651	-.056
209.3	1.107	.608	-.084
214.7	1.127	.622	.025
218.7	.966	.711	.076
224.7	.867	.485	.081
229.2	.843	.399	.065
234.8	1.008	.307	-.005
238.8	1.023	.318	-.007
244.8	.944	.256	-.011
249.1	.902	.166	-.002
254.9	.943	.103	-.011
258.9	.988	.073	-.009
264.8	.969	.121	-.008
269.1	.912	.133	-.001
274.9	.907	.182	.004
278.9	.839	.213	.043
284.7	.724	.240	.041
289.3	.469	.313	.052
294.9	.386	.347	.018
299.0	.385	.178	.019
304.9	.253	.331	-.029
309.4	0.000	0.000	0.000
314.9	0.000	0.000	0.000
319.0	0.000	0.000	0.000
324.9	.284	.030	-.002
334.8	.565	-.283	.056
338.8	.596	-.295	.059
344.7	.603	-.309	.032
349.2	.668	-.351	.011
358.8	.719	-.792	-.037
359.6	.915	-.502	-.034
365.0	.965	-.527	-.051
370.7	.999	-.513	-.065
374.8	.994	-.492	-.067

RADIUS = .512

ANGLE	VX/V	VT/V	VR/V
-8.9	.846	-.224	.058
-4.9	.748	-.290	.069
-1.0	.685	-.349	.017
3.0	.711	-.422	-.061
7.0	.776	-.459	-.091
9.4	.891	-.465	-.052
14.8	.961	-.440	-.005
18.9	1.009	-.399	.036
22.9	1.007	-.377	.058
26.8	1.022	-.355	.089
30.9	1.004	-.346	.113
38.8	.978	-.327	.159
58.9	.968	-.212	.247
69.3	.986	-.125	.282
78.9	.972	-.059	.289
89.4	.989	.049	.305
98.8	.966	.130	.310
109.3	.958	.237	.312
119.1	.968	.310	.290
129.5	.972	.399	.265
139.0	.991	.464	.223
151.5	1.004	.522	.163
158.8	1.025	.540	.118
171.3	1.046	.571	.045
179.4	1.045	.582	-.003
187.4	1.034	.572	-.059
190.9	1.029	.575	-.076
198.9	1.020	.561	-.124
209.4	1.013	.531	-.188
218.7	.988	.508	-.232
229.4	.997	.432	-.287
238.9	.983	.384	-.307
249.4	.966	.301	-.239
255.2	.970	.281	-.165
259.0	.968	.278	-.109
263.0	.964	.216	-.046
271.1	.941	.211	-.051
275.0	.883	.203	-.095
279.0	.852	.181	-.109
283.1	.763	.186	-.114
287.1	.700	.143	-.089
291.2	.552	.162	-.057
295.1	.411	.157	-.047
299.0	.346	.087	-.033
299.1	.237	.112	-.004
303.1	0.000	0.000	0.000
307.2	0.000	0.000	0.000
309.8	0.000	0.000	0.000
311.2	0.000	0.000	0.000
315.0	0.000	0.000	0.000
317.1	0.000	0.000	0.000
319.2	0.000	0.000	0.000
319.2	0.000	0.000	0.000
321.3	0.000	0.000	0.000
323.3	.675	-.533	-.132
327.0	.884	-.440	-.144
329.6	.935	-.401	-.155
331.0	.945	-.383	-.139
335.0	1.014	-.321	-.117
339.0	1.013	-.275	-.068
343.0	1.005	-.242	-.016
347.0	.921	-.216	.023
351.1	.846	-.224	.058
355.1	.748	-.290	.069
359.0	.685	-.349	.017
363.0	.711	-.422	-.061
367.0	.776	-.459	-.091
369.4	.891	-.465	-.052
374.8	.961	-.440	-.005

TABLE B-13 CONTINUED

RADIUS = .711

ANGLE	VX/V	VT/V	VR/V
-8.8	.977	-.280	-.044
-6.6	.954	-.255	-.022
-2.6	.872	-.226	.016
-.6	.822	-.231	.034
1.4	.746	-.242	.053
5.3	.699	-.298	.067
9.4	.773	-.385	.029
10.8	.813	-.426	.025
13.3	.884	-.436	.027
17.3	.994	-.424	.064
21.3	.995	-.389	.094
25.2	.993	-.377	.123
29.2	.991	-.359	.147
31.6	.990	-.344	.154
33.1	.980	-.356	.176
38.8	.975	-.341	.198
51.4	.993	-.261	.271
71.3	1.011	-.124	.330
78.9	1.005	-.080	.341
91.5	1.018	.039	.356
99.0	.994	.095	.361
111.4	.971	.193	.355
118.9	.953	.243	.340
131.6	.945	.329	.296
138.9	.941	.376	.258
151.4	.950	.436	.185
158.7	.957	.467	.139
171.4	.972	.490	.048
178.5	.978	.501	-.009
181.2	.972	.498	-.028
191.2	.956	.495	-.105
198.7	.942	.494	-.155
211.2	.936	.444	-.249
218.6	.933	.425	-.291
231.2	.949	.324	-.358
238.6	.952	.277	-.376
249.4	.972	.169	-.371
253.3	.991	.130	-.328
257.4	1.012	.063	-.287
258.7	1.024	.051	-.269
261.4	1.042	.006	-.246
265.3	1.048	-.047	-.227
269.3	1.046	-.089	-.237
271.1	1.031	-.103	-.258
273.4	1.020	-.112	-.269
277.4	1.019	-.114	-.268
281.6	1.036	-.122	-.263
285.6	.997	-.104	-.217
289.5	.968	-.084	-.141
291.4	.935	-.071	-.106
293.5	.909	-.059	-.079
297.5	.856	-.085	.020
301.7	.780	-.110	.077
305.6	.739	-.138	.128
309.6	.679	-.259	.150
313.6	.724	-.351	.111
317.6	.866	-.433	.034
319.0	.879	-.427	-.022
321.8	.993	-.398	-.064
325.7	1.008	-.345	-.103
329.6	1.017	-.333	-.114
333.6	1.016	-.323	-.120
337.7	1.023	-.319	-.114
341.6	1.026	-.318	-.098
345.6	1.025	-.310	-.079
349.5	1.016	-.290	-.049
350.9	.987	-.283	-.047
351.2	.977	-.280	-.044
353.4	.954	-.255	-.022
357.4	.872	-.226	.016
359.4	.822	-.231	.034
361.4	.746	-.242	.053
365.3	.699	-.298	.067
369.4	.773	-.385	.029
370.8	.813	-.426	.025

RADIUS = .911

ANGLE	VX/V	VT/V	VR/V
-9.3	1.007	-.266	-.075
-5.2	.999	-.252	-.044
-1.2	.983	-.219	0.000
-.7	.908	-.216	.001
1.2	.887	-.212	.024
2.6	.874	-.190	.038
3.2	.859	-.190	.046
6.8	.764	-.220	.068
10.5	.729	-.337	.088
11.2	.732	-.335	.086
14.5	.793	-.407	.076
18.6	.930	-.395	.096
22.5	.960	-.346	.107
26.6	.971	-.325	.143
30.6	.976	-.318	.177
34.5	.978	-.308	.204
41.1	.964	-.287	.251
51.2	.978	-.239	.312
61.2	.978	-.173	.359
71.2	.966	-.105	.384
81.2	1.002	-.029	.403
91.2	1.005	.052	.409
101.2	.967	.133	.412
111.5	.960	.212	.408
121.5	.974	.280	.383
131.5	.939	.351	.355
141.5	.951	.405	.302
151.3	.956	.452	.238
161.3	.974	.485	.170
171.2	.992	.504	.094
179.8	1.022	.515	.024
191.7	1.016	.520	-.069
201.6	1.007	.498	-.134
211.6	.989	.483	-.218
221.4	.984	.438	-.283
231.4	.977	.369	-.342
241.5	.966	.287	-.403
251.5	.995	.168	-.394
255.2	1.005	.102	-.364
259.0	1.021	.052	-.334
262.9	1.027	.011	-.326
266.8	1.026	-.057	-.320
270.9	1.009	-.087	-.323
274.8	.988	-.126	-.340
278.9	1.009	-.143	-.304
282.8	1.012	-.160	-.285
286.9	1.005	-.160	-.261
291.7	1.031	-.160	-.220
294.8	1.039	-.145	-.188
298.8	1.033	-.133	-.148
302.9	1.037	-.117	-.109
306.9	1.045	-.097	-.076
310.9	1.031	-.055	-.022
314.9	.964	-.032	.028
319.0	.873	-.105	.052
321.6	.869	-.210	.024
322.9	.897	-.215	.001

TABLE B-13 CONTINUED

326.9	1.000	-.211	-.064
331.5	1.008	-.207	-.102
334.8	1.006	-.210	-.112
338.8	1.015	-.237	-.107
342.7	1.009	-.257	-.106
346.7	1.015	-.267	-.099
350.7	1.007	-.266	-.075
354.8	.999	-.252	-.044
358.8	.983	-.219	0.000
359.3	.908	-.216	.001
361.2	.887	-.212	.024
362.6	.874	-.190	.038
363.2	.859	-.190	.046
366.8	.764	-.220	.068

333.3	.966	-.216	-.210
337.2	.957	-.252	-.202
341.2	.942	-.282	-.179
345.3	.963	-.318	-.154
348.8	.973	-.322	-.138
353.1	.976	-.324	-.112
357.0	.965	-.318	-.081
359.6	.942	-.296	-.046
363.6	.860	-.274	.005
367.4	.762	-.342	.065

RADIUS = 1.082

ANGLE	VX/V	VT/V	VR/V
-3.0	.965	-.318	-.081
-.4	.942	-.296	-.046
3.6	.860	-.274	.005
7.4	.762	-.342	.065
11.5	.733	-.391	.119
13.5	.795	-.426	.132
17.3	.908	-.451	.115
21.5	.958	-.415	.118
25.4	.986	-.384	.148
33.3	.966	-.369	.205
38.6	.961	-.363	.236
48.7	.964	-.324	.304
58.8	.970	-.266	.347
69.3	.999	-.166	.383
78.8	1.003	-.122	.397
89.3	1.038	-.015	.408
98.7	1.031	.038	.406
109.5	1.031	.134	.393
118.9	.991	.183	.408
129.7	.991	.266	.360
139.0	.987	.316	.330
149.5	1.008	.362	.251
158.9	1.006	.396	.203
169.6	1.017	.419	.107
179.6	1.024	.439	.028
189.3	1.021	.446	-.053
198.6	.996	.436	-.129
209.3	.990	.416	-.223
218.5	1.004	.377	-.285
229.3	.968	.320	-.374
238.7	.964	.267	-.424
249.3	.955	.141	-.465
253.3	.973	.102	-.457
258.7	.991	.038	-.437
261.2	1.027	-.018	-.415
265.3	1.021	-.068	-.403
269.2	.985	-.128	-.422
273.2	.962	-.169	-.402
277.3	.962	-.218	-.368
281.3	.933	-.243	-.327
285.4	.935	-.267	-.265
289.4	.956	-.267	-.197
293.4	.969	-.242	-.143
298.9	.970	-.227	-.100
301.6	.969	-.199	-.060
305.5	.936	-.163	-.053
309.5	.949	-.132	-.042
313.4	.967	-.096	-.040
317.5	.925	-.064	-.053
321.6	.930	-.034	-.034
325.3	.908	-.110	-.075
328.9	.972	-.203	-.183

TABLE B-14 - LISTING OF THE MEAN VELOCITY COMPONENT RATIOS, THE MEAN ADVANCE ANGLES AND OTHER DERIVED QUANTITIES AT THE EXPERIMENTAL AND INTERPOLATED RADII FOR EXPERIMENT 182

RADIUS =	.330	.512	.711	.911	1.082	.280	.300	.400	.500	.600	.700	.800	.900	1.000
VXBAR =	.886	.887	.956	.977	.976	.896	.891	.879	.885	.923	.953	.968	.977	.979
VTBAR =	.148	.122	.039	.074	.013	.147	.148	.144	.125	.071	.040	.069	.075	.053
VRBAR =	-.005	.037	.033	.041	.025	-.024	-.016	.016	.036	.034	.033	.040	.041	.035
1-WVX =	.890	.884	.905	.933	.947	0.000	.893	.885	.883	.891	.906	.921	.933	.942
1-WX =	.879	.846	.878	.915	.932	0.000	.892	.855	.848	.859	.882	.902	.915	.926
BBAR =	31.53	22.59	18.65	14.98	12.90	35.70	33.91	27.16	22.97	20.83	18.86	16.79	15.14	13.82
BPOS =	20.44	9.38	4.14	2.05	1.40	30.84	25.07	14.94	9.81	6.68	4.36	2.94	2.13	1.53
THETA =	10.00	20.00	17.50	347.50	25.00	357.50	357.50	12.50	20.00	17.50	17.50	340.00	347.50	295.00
BNEG =	-32.40	-23.71	-3.58	-2.39	-2.31	-33.80	-32.13	-30.82	-24.79	-11.96	-4.19	-2.33	-2.36	-2.49
THETA =	312.50	320.00	310.00	10.00	10.00	325.00	312.50	320.00	320.00	310.00	310.00	7.50	10.00	10.00

VXBAR IS CIRCUMFERENTIAL MEAN LONGITUDINAL VELOCITY.
VTBAR IS CIRCUMFERENTIAL MEAN TANGENTIAL VELOCITY.
VRBAR IS CIRCUMFERENTIAL MEAN RADIAL VELOCITY.
1-WVX IS VOLUMETRIC MEAN WAKE VELOCITY WITHOUT TANGENTIAL CORRECTION.
1-WX IS VOLUMETRIC MEAN WAKE VELOCITY WITH TANGENTIAL CORRECTION.
BBAR IS MEAN ANGLE OF ADVANCE.
BPOS IS VARIATION BETWEEN THE MAXIMUM AND MEAN ADVANCE ANGLES (DELTA BETA PLUS).
BNEG IS VARIATION BETWEEN THE MINIMUM AND MEAN ADVANCE ANGLES (DELTA BETA MINUS).
THETA IS ANGLE IN DEGREES AT WHICH CORRESPONDING BPOS OR BNEG OCCURS.

TABLE B-15 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIME: T 182

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .330								
AMPLITUDE =	.2935	.1671	.1543	.0910	.0646	.0287	.0157	.0265
PHASE ANGLE =	309.3	14.2	36.9	86.9	153.8	227.0	295.0	289.8
RADIUS = .512								
AMPLITUDE =	.1981	.1618	.1111	.1092	.0978	.1011	.0919	.0670
P: ASE ANGLE =	314.0	15.8	64.3	128.3	187.7	232.4	267.4	295.8
RADIUS = .711								
AMPLITUDE =	.0240	.0349	.0064	.0386	.0441	.0485	.0393	.0219
PHASE ANGLE =	325.0	310.0	357.9	142.3	207.8	237.4	265.9	282.9
RADIUS = .911								
AMPLITUDE =	.0259	.0193	.0299	.0065	.0184	.0177	.0249	.0250
PHASE ANGLE =	220.6	258.3	244.6	142.3	209.6	195.7	193.8	193.2
RADIUS = 1.082								
AMPLITUDE =	.0421	.0170	.0181	.0083	.0144	.0174	.0119	.0177
PHASE ANGLE =	293.3	256.6	228.4	145.2	237.4	223.1	187.1	182.6

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .330								
AMPLITUDE =	.0256	.0102	.0314	.0306	.0139	.0087	.0202	.0184
PHASE ANGLE =	353.2	334.1	.7	67.1	141.4	66.9	170.9	278.3
RADIUS = .512								
AMPLITUDE =	.0460	.0262	.0156	.0106	.0079	.0115	.0148	.0133
PHASE ANGLE =	324.0	351.0	40.0	106.2	158.8	187.7	202.6	230.1
RADIUS = .711								
AMPLITUDE =	.0116	.0061	.0164	.0207	.0175	.0125	.0094	.0048
PHASE ANGLE =	283.3	183.7	171.1	188.5	214.0	221.2	222.2	228.6
RADIUS = .911								
AMPLITUDE =	.0174	.0079	.0089	.0121	.0102	.0123	.0120	.0082
PHASE ANGLE =	219.2	242.6	169.8	125.4	107.3	123.6	138.5	154.3
RADIUS = 1.082								
AMPLITUDE =	.0190	.0066	.0116	.0128	.0105	.0068	.0104	.0095
PHASE ANGLE =	211.3	169.0	144.8	145.1	153.8	122.3	117.2	131.5

TABLE B-16 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 182

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .280								
AMPLITUDE =	.3094	.1472	.1675	.0939	.0558	.0120	.0304	.0050
PHASE ANGLE =	307.7	11.3	26.2	62.9	124.8	67.9	67.5	222.9
RADIUS = .300								
AMPLITUDE =	.3036	.1562	.1617	.0909	.0579	.0063	.0138	.0128
PHASE ANGLE =	308.4	12.7	30.6	72.9	138.2	203.9	46.5	278.1
RADIUS = .400								
AMPLITUDE =	.2639	.1797	.1398	.1010	.0838	.0702	.0583	.0513
PHASE ANGLE =	311.3	16.1	49.7	110.3	174.2	230.9	271.2	294.8
RADIUS = .500								
AMPLITUDE =	.2063	.1660	.1150	.1097	.0977	.0999	.0904	.0668
PHASE ANGLE =	313.7	16.0	63.0	127.1	186.7	232.3	267.6	295.9
RADIUS = .600								
AMPLITUDE =	.1027	.0837	.0539	.0728	.0696	.0756	.0662	.0445
PHASE ANGLE =	317.5	2.1	60.0	133.2	195.6	235.6	269.3	295.4
RADIUS = .700								
AMPLITUDE =	.0298	.0367	.0088	.0414	.0461	.0509	.0417	.0238
PHASE ANGLE =	324.1	317.4	22.5	141.2	206.5	237.4	266.8	285.6
RADIUS = .800								
AMPLITUDE =	.0150	.0237	.0185	.0198	.0301	.0286	.0268	.0184
PHASE ANGLE =	234.3	287.6	254.9	142.1	206.5	221.2	230.4	225.1
RADIUS = .900								
AMPLITUDE =	.0255	.0195	.0295	.0073	.0192	.0183	.0250	.0246
PHASE ANGLE =	219.0	260.5	245.3	142.2	208.9	197.6	196.2	194.8
RADIUS = 1.000								
AMPLITUDE =	.0274	.0184	.0282	.0041	.0138	.0150	.0213	.0246
PHASE ANGLE =	251.3	249.2	239.3	144.7	221.5	196.0	182.3	185.1

TABLE B-16 CONTINUED

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .280								
AMPLITUDE =	.0180	.0051	.0360	.0376	.0164	.0152	.0228	.0224
PHASE ANGLE =	33.8	233.6	352.0	85.1	145.5	47.4	162.1	292.1
RADIUS = .300								
AMPLITUDE =	.0200	.0048	.0341	.0347	.0153	.0123	.0217	.0206
PHASE ANGLE =	12.8	298.2	355.4	65.8	143.7	53.2	165.5	286.9
RADIUS = .400								
AMPLITUDE =	.0387	.0213	.0254	.0215	.0110	.0058	.0175	.0153
PHASE ANGLE =	334.5	347.3	13.6	73.0	139.9	136.7	183.8	256.9
RADIUS = .500								
AMPLITUDE =	.0462	.0264	.0167	.0114	.0081	.0110	.0150	.0135
PHASE ANGLE =	324.8	350.8	36.4	99.9	155.0	185.3	200.8	232.2
RADIUS = .600								
AMPLITUDE =	.0268	.0076	.0077	.0145	.0144	.0130	.0124	.0089
PHASE ANGLE =	317.2	350.9	129.5	175.5	207.5	215.6	219.0	235.8
RADIUS = .700								
AMPLITUDE =	.0125	.0052	.0159	.0205	.0176	.0128	.0097	.0052
PHASE ANGLE =	289.2	183.6	169.8	188.4	214.2	221.8	223.2	231.0
RADIUS = .800								
AMPLITUDE =	.0129	.0069	.0118	.0130	.0072	.0090	.0089	.0058
PHASE ANGLE =	241.1	232.6	174.3	158.4	161.6	159.3	168.9	180.2
RADIUS = .900								
AMPLITUDE =	.0170	.0079	.0090	.0120	.0099	.0122	.0118	.0080
PHASE ANGLE =	220.4	243.1	170.9	127.1	108.5	125.2	140.3	156.1
RADIUS = 1.000								
AMPLITUDE =	.0193	.0062	.0090	.0123	.0106	.0115	.0124	.0093
PHASE ANGLE =	213.0	223.2	156.8	125.1	115.1	117.3	127.1	142.2

TABLE B-17 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 182

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .330								
AMPLITUDE =	.5392	.1321	.0944	.0649	.0276	.0155	.0168	.0113
PHASE ANGLE =	260.3	182.2	243.0	323.0	57.5	201.0	249.9	286.6
RADIUS = .512								
AMPLITUDE =	.4754	.0515	.0208	.0191	.0214	.0225	.0240	.0244
PHASE ANGLE =	259.7	204.7	286.2	356.8	84.2	129.5	155.0	170.6
RADIUS = .711								
AMPLITUDE =	.4393	.0408	.0249	.0058	.0286	.0348	.0287	.0162
PHASE ANGLE =	270.2	98.7	148.6	51.9	78.5	122.3	161.1	219.6
RADIUS = .911								
AMPLITUDE =	.4131	.0621	.0531	.0269	.0179	.0199	.0181	.0128
PHASE ANGLE =	268.9	109.6	165.2	245.2	356.5	65.1	102.0	114.5
RADIUS = 1.082								
AMPLITUDE =	.3975	.0657	.0676	.0414	.0266	.0218	.0151	.0126
PHASE ANGLE =	267.5	114.1	165.5	232.1	307.4	10.4	63.9	85.9

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .330								
AMPLITUDE =	.0122	.0083	.0056	.0002	.0158	.0216	.0114	.0089
PHASE ANGLE =	313.4	37.9	192.4	36.2	176.2	256.0	328.6	253.1
RADIUS = .512								
AMPLITUDE =	.0252	.0232	.0201	.0162	.0129	.0118	.0120	.0131
PHASE ANGLE =	189.7	197.5	223.9	256.2	300.1	342.7	33.6	76.6
RADIUS = .711								
AMPLITUDE =	.0069	.0083	.0129	.0135	.0131	.0087	.0045	.0017
PHASE ANGLE =	298.8	51.2	79.2	86.0	99.8	128.5	137.7	132.5
RADIUS = .911								
AMPLITUDE =	.0098	.0071	.0025	.0086	.0100	.0117	.0107	.0074
PHASE ANGLE =	119.5	120.7	64.6	24.8	38.1	37.9	54.6	70.7
RADIUS = 1.082								
AMPLITUDE =	.0118	.0109	.0077	.0037	.0026	.0058	.0043	.0073
PHASE ANGLE =	105.8	113.9	106.4	91.7	8.1	5.3	14.6	26.7

TABLE B-18 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 182

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .280								
AMPLITUDE =	.5610	.1639	.1274	.0843	.0328	.0205	.0274	.0260
PHASE ANGLE =	261.7	176.0	237.5	319.2	50.1	222.4	270.9	311.1
RADIUS = .300								
AMPLITUDE =	.5520	.1505	.1135	.0762	.0305	.0181	.0226	.0194
PHASE ANGLE =	261.1	178.4	239.5	320.6	52.9	215.1	264.5	305.3
RADIUS = .400								
AMPLITUDE =	.5119	.0959	.0579	.0425	.0231	.0147	.0135	.0117
PHASE ANGLE =	259.1	191.8	254.1	330.8	69.3	161.7	192.0	189.6
RADIUS = .500								
AMPLITUDE =	.4789	.0558	.0237	.0209	.0213	.0216	.0230	.0237
PHASE ANGLE =	259.5	203.9	281.6	352.9	83.2	131.3	156.3	170.7
RADIUS = .600								
AMPLITUDE =	.4562	.0248	.0060	.0134	.0288	.0325	.0290	.0196
PHASE ANGLE =	265.6	153.0	193.7	25.0	84.7	128.1	162.6	200.2
RADIUS = .700								
AMPLITUDE =	.4408	.0387	.0231	.0068	.0291	.0351	.0291	.0167
PHASE ANGLE =	269.9	100.4	148.6	49.4	79.5	123.2	161.7	218.9
RADIUS = .800								
AMPLITUDE =	.4266	.0524	.0386	.0113	.0193	.0255	.0212	.0095
PHASE ANGLE =	269.7	105.2	160.6	255.5	47.8	101.4	135.9	166.6
RADIUS = .900								
AMPLITUDE =	.4144	.0613	.0518	.0256	.0176	.0201	.0182	.0124
PHASE ANGLE =	269.0	109.3	165.0	246.0	1.1	69.0	105.1	117.4
RADIUS = 1.000								
AMPLITUDE =	.4042	.0657	.0618	.0358	.0220	.0198	.0171	.0143
PHASE ANGLE =	268.2	112.1	166.0	238.9	326.6	34.4	80.7	98.3

TABLE B-18 CONTINUED

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	9	10	11	12	13	14	15	16
RADIUS = .280								
AMPLITUDE =	.0296	.0265	.0085	.0120	.0287	.0310	.0142	.0205
PHASE ANGLE =	337.7	28.0	83.0	76.8	159.4	240.8	302.2	253.8
RADIUS = .300								
AMPLITUDE =	.0218	.0187	.0046	.0069	.0230	.0268	.0127	.0156
PHASE ANGLE =	332.0	29.9	112.6	76.2	164.4	246.1	312.1	253.6
RADIUS = .400								
AMPLITUDE =	.0127	.0108	.0156	.0110	.0084	.0141	.0113	.0033
PHASE ANGLE =	210.1	192.3	221.3	257.9	243.3	289.5	3.5	79.0
RADIUS = .500								
AMPLITUDE =	.0247	.0229	.0203	.0164	.0128	.0120	.0121	.0127
PHASE ANGLE =	190.1	197.5	224.2	256.5	297.4	338.3	31.2	76.6
RADIUS = .600								
AMPLITUDE =	.0106	.0057	.0053	.0028	.0033	.0023	.0041	.0056
PHASE ANGLE =	221.6	173.5	153.3	135.5	84.5	87.9	71.2	87.6
RADIUS = .700								
AMPLITUDE =	.0069	.0076	.0123	.0129	.0126	.0083	.0043	.0018
PHASE ANGLE =	293.0	52.7	80.8	87.3	100.2	129.2	136.8	127.8
RADIUS = .800								
AMPLITUDE =	.0026	.0057	.0062	.0099	.0109	.0088	.0079	.0052
PHASE ANGLE =	130.1	88.0	69.9	51.5	65.9	65.9	71.3	86.6
RADIUS = .900								
AMPLITUDE =	.0093	.0069	.0026	.0088	.0102	.0116	.0107	.0073
PHASE ANGLE =	120.1	119.4	62.8	26.1	40.1	39.6	55.7	72.3
RADIUS = 1.000								
AMPLITUDE =	.0122	.0091	.0033	.0059	.0074	.0103	.0088	.0076
PHASE ANGLE =	114.2	122.2	96.7	26.9	25.1	26.1	44.5	53.7

TABLE B-19

INPUT DATA FOR HARMONIC ANALYSIS FOR FF 1088, MODEL 4989, EXPERIMENT 183

INPUT DATA

RADIUS = .330

ANGLE	VX/V	VT/V	VR/V
-14.5	.698	-.190	.118
-10.9	.728	-.191	.095
-4.4	.710	-.250	.057
-1.0	.715	-.317	.021
3.7	.863	-.374	0.000
5.3	.891	-.393	-.002
8.7	.944	-.414	-.011
15.3	1.045	-.365	-.024
18.7	1.028	-.360	-.033
25.3	1.033	-.331	-.041
29.6	1.025	-.309	-.039
35.2	1.007	-.306	-.038
38.5	.995	-.299	-.034
44.9	.986	-.278	-.030
58.6	.973	-.202	-.019
69.3	.988	-.109	-.009
75.4	.974	-.057	-.005
89.3	.966	.056	-.008
95.4	.968	.108	-.010
98.5	.957	.124	-.009
109.2	1.019	.217	-.006
115.5	1.020	.266	-.003
118.6	1.044	.281	-.003
129.4	1.054	.364	-.010
138.7	1.069	.420	-.010
149.3	1.071	.500	-.019
158.6	1.117	.521	-.020
169.3	1.098	.557	-.032
178.7	1.112	.561	-.041
189.1	1.115	.559	-.050
198.5	1.094	.544	-.059
209.1	1.101	.502	-.066
218.4	1.132	.485	-.011
225.3	1.144	.438	-.021
229.0	1.142	.420	.013
235.3	1.056	.394	.081
238.5	.997	.342	.121
245.3	.948	.256	.085
248.9	.899	.202	.044
255.3	.897	.080	.010
258.5	.959	.008	-.005
265.2	.929	.040	-.007
269.0	.887	.090	-.008
275.3	.822	.148	.018
285.3	.648	.203	.054
289.1	.522	.195	.053
295.4	.432	.062	.071
305.4	.342	-.063	.116
315.6	.425	-.137	.108
325.6	.628	-.271	.087
329.4	.684	-.291	.094
335.6	.769	-.256	.122
338.8	.707	-.235	.136
345.5	.698	-.190	.118
355.6	.710	-.250	.057
358.7	.719	-.314	.031
359.0	.715	-.317	.021
363.7	.863	-.374	0.000
365.3	.891	-.393	-.002
368.7	.944	-.414	-.011
375.3	1.045	-.365	-.024
378.7	1.028	-.360	-.033

RADIUS = .512

ANGLE	VX/V	VT/V	VR/V
-10.6	.982	-.183	0.000
-5.6	.947	-.140	.039
-.9	.826	-.140	.062
4.5	.767	-.217	.052
9.2	.769	-.323	.003
14.5	.901	-.331	-.026
18.5	.989	-.307	.012
24.5	.991	-.270	.057
29.1	1.010	-.245	.074
34.4	1.001	-.236	.094
38.4	.986	-.231	.108
58.6	.971	-.158	.173
68.9	.976	-.103	.207
78.6	.984	-.053	.218
89.0	.997	.019	.234
98.5	.977	.079	.235
109.1	.976	.155	.241
118.7	.979	.213	.229
129.4	.980	.278	.212
138.9	.995	.328	.183
149.3	1.007	.375	.149
158.8	1.036	.405	.107
169.2	1.044	.426	.064
169.2	1.043	.427	.065
178.7	1.055	.446	.020
179.3	1.052	.448	.018
179.6	1.051	.444	.015
188.6	1.046	.450	-.020
199.0	1.041	.441	-.072
209.5	1.020	.415	-.125
218.8	1.014	.391	-.167
229.3	1.009	.332	-.205
238.7	.997	.292	-.233
249.2	.983	.221	-.209
258.7	.973	.162	-.100
269.3	.948	.091	-.050
271.2	.924	.075	-.062
275.2	.912	.055	-.109
278.5	.909	.019	-.129
279.2	.899	.040	-.131
283.2	.897	.017	-.131
287.1	.861	.022	-.102
289.2	.822	.025	-.077
291.2	.810	.025	-.045
294.6	.790	.032	-.040
295.2	.745	.024	-.005
299.2	.673	.020	.013
303.3	.599	-.090	.093
307.3	.611	-.175	.171
309.4	.650	-.179	.161
311.3	.666	-.222	.180
314.7	.691	-.252	.156
318.7	.785	-.298	.119
319.0	.790	-.321	.116
324.8	.933	-.283	.022
329.3	.992	-.236	-.036
334.6	.983	-.216	-.054
338.7	.987	-.206	-.057
349.4	.982	-.183	0.000
354.4	.947	-.140	.039
359.1	.826	-.140	.062
364.5	.767	-.217	.052
369.2	.769	-.323	.003
374.5	.901	-.331	-.026
378.5	.989	-.307	.012

TABLE B-19 CONTINUED

RADIUS = .711

ANGLE	VX/V	VT/V	VR/V
-1.2	.996	-.183	-.032
4.8	.930	-.145	.017
5.5	.866	-.145	.015
8.7	.792	-.185	.051
9.5	.807	-.191	.060
14.9	.863	-.316	.044
18.8	.964	-.309	.036
29.4	1.003	-.254	.098
34.7	.990	-.251	.123
38.8	.983	-.243	.139
49.3	.993	-.203	.179
58.8	.983	-.176	.214
69.3	1.000	-.120	.242
78.7	1.003	-.076	.258
89.2	1.015	-.002	.273
98.7	.999	.044	.275
109.2	.981	.111	.276
118.7	.977	.153	.268
129.3	.966	.214	.247
138.8	.970	.249	.219
149.3	.967	.296	.176
158.7	.971	.319	.135
169.2	.981	.346	.079
178.6	.994	.357	.027
189.2	.978	.361	-.037
198.5	.979	.360	-.086
209.1	.964	.345	-.155
218.4	.957	.319	-.203
229.1	.962	.271	-.256
238.6	.971	.222	-.297
248.9	.990	.139	-.299
255.3	1.000	.091	-.277
259.2	1.016	.041	-.259
265.0	1.036	-.021	-.258
268.9	1.045	-.067	-.251
274.9	1.035	-.109	-.259
278.6	1.040	-.126	-.251
284.8	1.023	-.151	-.241
289.1	1.000	-.157	-.202
294.9	.999	-.151	-.154
304.9	.981	-.129	-.052
309.4	.967	-.122	-.003
312.9	.970	-.065	.019
315.0	.944	-.043	.046
317.0	.878	-.021	.062
318.9	.824	-.040	.073
319.0	.763	-.051	.102
321.1	.736	-.118	.086
323.0	.730	-.176	.087
325.1	.842	-.235	.029
327.0	.928	-.245	-.025
329.1	.973	-.214	-.064
334.9	1.004	-.172	-.090
337.1	1.010	-.179	-.088
338.8	1.003	-.179	-.091
341.0	1.008	-.189	-.086
344.9	1.009	-.198	-.081
344.9	1.013	-.199	-.081
354.9	1.028	-.208	-.048
358.8	.996	-.183	-.032
364.8	.930	-.145	.017
365.5	.866	-.145	.015
368.7	.792	-.185	.051
369.5	.807	-.191	.060
374.9	.863	-.316	.044

RADIUS = .911

ANGLE	VX/V	VT/V	VR/V
-15.5	.989	-.143	-.106
-10.8	.995	-.161	-.087
-5.6	1.003	-.177	-.074
-2.9	1.003	-.175	-.061
-1.4	1.000	-.172	-.061
1.0	.981	-.164	-.040
5.2	.927	-.137	-.006
9.2	.847	-.129	.055
12.6	.786	-.186	.075
16.5	.810	-.289	.093
18.5	.903	-.292	.089
20.6	.924	-.279	.086
24.5	.973	-.246	.097
29.2	.980	-.220	.118
34.4	.971	-.208	.140
38.5	.962	-.204	.156
44.4	.966	-.189	.185
49.0	.978	-.170	.204
58.5	.959	-.141	.235
68.9	.977	-.094	.272
78.5	.987	-.052	.291
88.9	1.016	.009	.310
98.5	.997	.059	.315
109.2	.983	.123	.317
118.8	.970	.173	.304
129.4	.968	.232	.282
138.9	.967	.276	.258
149.3	.973	.319	.214
158.8	.977	.344	.167
169.3	.989	.370	.108
178.9	1.005	.387	.059
189.5	1.026	.392	.001
198.8	1.008	.396	-.052
209.3	.977	.385	-.123
218.7	.970	.369	-.186
229.3	.963	.325	-.247
238.7	.960	.279	-.296
249.3	.972	.191	-.329
254.8	.978	.130	-.319
258.7	.987	.115	-.310
264.7	.997	.010	-.309
269.3	.973	-.050	-.304
274.6	.943	-.097	-.287
278.6	.961	-.141	-.256
284.7	.976	-.192	-.205
289.2	1.005	-.204	-.138
294.6	.999	-.196	-.076
304.7	.993	-.138	.029
309.4	.977	-.110	.070
312.6	.964	-.088	.079
316.7	.950	-.058	.094
318.7	.931	-.044	.112
320.7	.924	-.028	.129
324.6	.859	.018	.111
328.7	.870	-.122	-.062
332.7	.911	-.096	-.128
336.5	.960	-.108	-.130
340.6	.977	-.126	-.119
344.5	.989	-.143	-.106
349.2	.995	-.161	-.087
354.4	1.003	-.177	-.074
357.1	1.003	-.175	-.061
358.6	1.000	-.172	-.061
361.0	.981	-.164	-.040
365.2	.927	-.137	-.006
369.2	.847	-.129	.055

TABLE B-19 CONTINUED

RADIUS = 1.082

ANGLE	VX/V	VT/V	VR/V
-1.3	.969	-.221	-.105
1.6	.970	-.218	-.088
5.6	.953	-.201	-.053
9.6	.898	-.197	-.005
13.5	.834	-.230	.061
17.6	.892	-.318	.126
18.9	.901	-.335	.130
21.6	.950	-.308	.135
25.5	.968	-.268	.125
29.5	.962	-.253	.129
49.3	.972	-.223	.207
58.8	.951	-.197	.246
69.2	.979	-.142	.275
78.7	.977	-.101	.300
89.2	1.019	-.039	.310
98.6	1.002	.012	.324
109.1	1.002	.071	.312
118.7	.984	.117	.314
129.4	.997	.169	.277
138.8	.988	.209	.270
149.3	.949	.249	.214
158.7	.994	.276	.181
169.2	1.004	.297	.111
179.2	1.018	.307	.053
189.1	1.038	.317	-.005
198.5	1.028	.322	-.058
209.1	.998	.311	-.134
218.4	.989	.297	-.187
229.0	.984	.266	-.262
238.5	.973	.232	-.316
248.9	.967	.172	-.382
252.8	.942	.143	-.390
256.9	.925	.104	-.387
258.6	.942	.097	-.333
265.0	.953	-.012	-.386
268.9	.940	-.090	-.389
273.0	.947	-.151	-.390
277.0	.936	-.208	-.372
281.0	.929	-.276	-.337
285.1	.935	-.324	-.272
289.1	.956	-.344	-.180
293.2	.985	-.341	-.087
298.7	1.008	-.294	.020
301.4	1.006	-.271	.062
305.3	1.008	-.225	.102
313.3	1.003	-.135	.130
317.5	.969	-.100	.126
321.4	.935	-.071	.131
325.3	.878	.006	.102
329.3	.804	-.104	-.076
333.3	.856	-.068	-.139
337.2	.867	-.083	-.157
338.8	.874	-.099	-.170
341.3	.880	-.118	-.171
345.2	.901	-.153	-.172
351.3	.936	-.201	-.151
355.2	.942	-.217	-.125
358.7	.969	-.221	-.105
361.6	.970	-.218	-.088
365.6	.953	-.201	-.053
369.6	.898	-.197	-.005
373.5	.834	-.230	.061
377.6	.892	-.318	.126

TABLE B-20 - LISTING OF THE MEAN VELOCITY COMPONENET RATIOS, THE MEAN ADVANCE ANGLES AND OTHER DERIVED QUANTITIES AT THE EXPERIMENTAL AND INTERPOLATED RADII FOR EXPERIMENT 183

RADIUS =	.330	.512	.711	.911	1.082	.280	.300	.400	.500	.600	.700	.800	.900	1.000
VXBAR =	.921	.955	.979	.971	.970	.910	.915	.935	.953	.969	.978	.974	.971	.970
VTBAR =	.107	.076	.031	.061	.006	.114	.112	.096	.078	.046	.031	.057	.062	.042
VRBAR =	.011	.042	.016	.037	.026	-.007	.000	.029	.042	.025	.016	.030	.037	.035
1-WVX =	.916	.936	.954	.964	.966	0.000	.913	.924	.935	.945	.954	.960	.963	.965
1-WX =	.876	.898	.929	.946	.951	0.000	.874	.882	.897	.915	.931	.941	.945	.948
BBAR =	33.29	24.59	19.12	14.94	12.84	36.87	35.35	29.30	25.02	21.97	19.38	16.94	15.11	13.73
BPOS =	15.03	5.63	2.80	1.67	1.47	20.49	18.12	9.96	5.96	4.05	2.90	2.16	1.69	1.47
THETA =	15.00	20.00	25.00	290.00	297.50	10.00	12.50	17.50	20.00	22.50	25.00	352.50	290.00	292.50
BNEG =	-17.78	-7.20	-3.73	-1.88	-1.80	-22.14	-20.10	-13.14	-7.79	-2.57	-3.70	-2.04	-1.91	-1.54
THETA =	305.00	302.50	322.50	12.50	330.00	310.00	307.50	302.50	302.50	320.00	322.50	322.50	12.50	12.50

VXBAR IS CIRCUMFERENTIAL MEAN LONGITUDINAL VELOCITY.
VTBAR IS CIRCUMFERENTIAL MEAN TANGENTIAL VELOCITY.
VRBAR IS CIRCUMFERENTIAL MEAN RADIAL VELOCITY.
1-WVX IS VOLUMETRIC MEAN WAKE VELOCITY WITHOUT TANGENTIAL CORRECTION.
1-WX IS VOLUMETRIC MEAN WAKE VELOCITY WITH TANGENTIAL CORRECTION.
BBAR IS MEAN ANGLE OF ADVANCE.
BPOS IS VARIATION BETWEEN THE MAXIMUM AND MEAN ADVANCE ANGLES (DELTA BETA PLUS).
BNEG IS VARIATION BETWEEN THE MINIMUM AND MEAN ADVANCE ANGLES (DELTA BETA MINUS).
THETA IS ANGLE IN DEGREES AT WHICH CORRESPONDING BPOS OR BNEG OCCURS.

TABLE B-21 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 183

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .330								
AMPLITUDE =	.2284	.1519	.0787	.0207	.0245	.0420	.0522	.0204
PHASE ANGLE =	306.3	20.9	56.0	125.5	199.8	264.8	314.8	1.2
RADIUS = .512								
AMPLITUDE =	.0859	.0559	.0220	.0398	.0432	.0466	.0370	.0191
PHASE ANGLE =	302.3	25.4	90.0	154.8	213.3	239.4	262.3	279.2
RADIUS = .711								
AMPLITUDE =	.0065	.0225	.0113	.0213	.0180	.0208	.0235	.0209
PHASE ANGLE =	279.5	286.4	325.4	101.2	166.6	187.6	194.8	195.3
RADIUS = .911								
AMPLITUDE =	.0220	.0101	.0159	.0116	.0074	.0128	.0258	.0191
PHASE ANGLE =	277.9	270.7	244.2	83.4	175.4	150.5	165.4	170.7
RADIUS = 1.082								
AMPLITUDE =	.0415	.0077	.0165	.0151	.0128	.0131	.0181	.0161
PHASE ANGLE =	290.0	284.6	257.0	352.8	7.9	83.0	136.7	131.8

HARMONIC =	9	10	11	12	13	14	15
RADIUS = .330							
AMPLITUDE =	.0071	.0164	.0070	.0027	.0027	.0019	.0067
PHASE ANGLE =	292.6	336.4	37.7	300.7	335.3	22.4	196.2
RADIUS = .512							
AMPLITUDE =	.0038	.0068	.0150	.0161	.0096	.0064	.0057
PHASE ANGLE =	303.4	156.6	165.6	187.3	207.3	210.3	186.6
RADIUS = .711							
AMPLITUDE =	.0172	.0107	.0008	.0088	.0130	.0159	.0152
PHASE ANGLE =	213.8	228.4	275.8	88.5	91.6	109.2	119.4
RADIUS = .911							
AMPLITUDE =	.0138	.0058	.0097	.0056	.0053	.0088	.0110
PHASE ANGLE =	188.2	172.2	147.2	136.8	76.7	58.3	71.9
RADIUS = 1.082							
AMPLITUDE =	.0129	.0060	.0039	.0041	.0024	.0039	.0075
PHASE ANGLE =	164.7	174.9	152.7	89.3	124.8	22.5	51.1

TABLE B-22 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 183

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .280								
AMPLITUDE =	.2792	.1858	.1031	.0177	.0147	.0373	.0618	.0269
PHASE ANGLE =	307.0	19.0	51.0	78.7	169.0	278.4	328.3	24.1
RADIUS = .300								
AMPLITUDE =	.2583	.1718	.0929	.0174	.0182	.0392	.0576	.0238
PHASE ANGLE =	306.7	19.7	52.8	100.5	186.3	272.3	323.1	15.8
RADIUS = .400								
AMPLITUDE =	.1657	.1101	.0512	.0319	.0367	.0470	.0439	.0177
PHASE ANGLE =	305.2	23.5	65.6	148.8	211.0	252.6	294.1	323.3
RADIUS = .500								
AMPLITUDE =	.0933	.0610	.0244	.0398	.0434	.0472	.0376	.0190
PHASE ANGLE =	302.7	25.6	86.8	154.9	213.5	240.7	265.5	283.2
RADIUS = .600								
AMPLITUDE =	.0390	.0265	.0100	.0276	.0279	.0307	.0255	.0161
PHASE ANGLE =	301.4	353.1	43.8	132.6	195.7	221.0	234.8	230.4
RADIUS = .700								
AMPLITUDE =	.0083	.0220	.0108	.0217	.0187	.0214	.0233	.0205
PHASE ANGLE =	286.4	290.8	330.4	103.9	169.4	191.0	198.0	197.5
RADIUS = .800								
AMPLITUDE =	.0126	.0156	.0107	.0178	.0149	.0172	.0258	.0208
PHASE ANGLE =	272.1	279.1	266.9	100.1	172.6	175.2	179.3	185.4
RADIUS = .900								
AMPLITUDE =	.0210	.0105	.0155	.0122	.0084	.0132	.0259	.0193
PHASE ANGLE =	277.1	271.2	244.9	86.6	175.5	153.7	166.8	172.4
RADIUS = 1.000								
AMPLITUDE =	.0312	.0079	.0174	.0090	.0019	.0111	.0228	.0172
PHASE ANGLE =	284.3	271.7	245.5	34.7	22.5	116.9	153.6	153.9

TABLE B-22 CONTINUED

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	9	10	11	12	13	14	15
RADIUS = .280							
AMPLITUDE =	.0091	.0273	.0171	.0116	.0091	.0073	.0070
PHASE ANGLE =	273.3	333.2	12.9	355.9	18.9	46.4	182.2
RADIUS = .300							
AMPLITUDE =	.0081	.0227	.0126	.0074	.0061	.0049	.0068
PHASE ANGLE =	280.9	334.3	18.7	348.0	10.8	41.9	188.5
RADIUS = .400							
AMPLITUDE =	.0059	.0046	.0075	.0095	.0060	.0037	.0064
PHASE ANGLE =	314.3	349.4	143.2	200.5	229.9	238.6	204.8
RADIUS = .500							
AMPLITUDE =	.0040	.0061	.0147	.0159	.0096	.0064	.0057
PHASE ANGLE =	309.3	154.1	164.8	188.5	209.6	214.1	190.7
RADIUS = .600							
AMPLITUDE =	.0106	.0082	.0053	.0078	.0076	.0104	.0110
PHASE ANGLE =	226.7	212.6	175.4	143.4	122.7	129.4	136.7
RADIUS = .700							
AMPLITUDE =	.0168	.0107	.0008	.0086	.0127	.0157	.0150
PHASE ANGLE =	214.7	228.1	260.7	90.8	92.9	110.5	120.8
RADIUS = .800							
AMPLITUDE =	.0153	.0069	.0063	.0066	.0090	.0116	.0124
PHASE ANGLE =	203.0	204.8	149.0	116.4	83.9	87.0	96.4
RADIUS = .900							
AMPLITUDE =	.0139	.0058	.0096	.0057	.0056	.0090	.0111
PHASE ANGLE =	189.7	174.5	147.2	136.0	77.0	60.9	73.9
RADIUS = 1.000							
AMPLITUDE =	.0131	.0059	.0084	.0045	.0031	.0067	.0097
PHASE ANGLE =	175.8	164.7	147.8	129.3	84.0	39.7	58.9

TABLE B-23 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 183

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .330								
AMPLITUDE =	.4375	.0451	.0269	.0224	.0371	.0407	.0318	.0077
PHASE ANGLE =	263.7	161.0	237.7	359.0	82.8	164.0	224.3	290.7
RADIUS = .512								
AMPLITUDE =	.3607	.0192	.0129	.0163	.0245	.0268	.0238	.0155
PHASE ANGLE =	264.3	88.5	81.1	82.6	114.4	143.9	172.4	203.9
RADIUS = .711								
AMPLITUDE =	.3042	.0486	.0401	.0169	.0110	.0148	.0162	.0118
PHASE ANGLE =	267.5	97.6	154.1	229.1	346.4	57.3	92.7	106.9
RADIUS = .911								
AMPLITUDE =	.3013	.0624	.0564	.0372	.0182	.0136	.0131	.0107
PHASE ANGLE =	267.0	86.1	147.8	215.3	285.1	4.5	56.2	73.8
RADIUS = 1.082								
AMPLITUDE =	.2849	.0685	.0733	.0549	.0374	.0228	.0140	.0072
PHASE ANGLE =	267.8	81.8	138.1	203.0	266.1	329.0	43.8	89.2

HARMONIC =	9	10	11	12	13	14	15
RADIUS = .330							
AMPLITUDE =	.0152	.0188	.0148	.0058	.0024	.0031	.0026
PHASE ANGLE =	137.1	182.3	230.5	257.3	258.7	265.3	35.8
RADIUS = .512							
AMPLITUDE =	.0048	.0062	.0118	.0127	.0087	.0043	.0042
PHASE ANGLE =	246.7	58.2	82.3	107.3	122.0	130.0	86.2
RADIUS = .711							
AMPLITUDE =	.0082	.0051	.0003	.0056	.0101	.0114	.0106
PHASE ANGLE =	105.6	118.9	21.8	343.6	359.4	17.5	29.8
RADIUS = .911							
AMPLITUDE =	.0077	.0068	.0046	.0033	.0047	.0059	.0069
PHASE ANGLE =	71.4	70.1	56.5	29.7	346.5	336.3	330.8
RADIUS = 1.082							
AMPLITUDE =	.0035	.0057	.0063	.0048	.0046	.0039	.0042
PHASE ANGLE =	69.9	32.7	34.9	10.5	354.0	333.7	315.2

TABLE B-24 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 183

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	1	2	3	4	5	6	7	8
RADIUS = .280								
AMPLITUDE =	.4628	.0651	.0466	.0317	.0419	.0432	.0367	.0128
PHASE ANGLE =	263.7	164.8	234.0	337.5	70.1	168.4	239.0	337.4
RADIUS = .300								
AMPLITUDE =	.4525	.0566	.0382	.0274	.0398	.0423	.0345	.0100
PHASE ANGLE =	263.7	163.7	235.3	345.1	75.2	166.7	233.2	323.1
RADIUS = .400								
AMPLITUDE =	.4052	.0247	.0060	.0174	.0325	.0362	.0278	.0110
PHASE ANGLE =	263.7	145.8	247.6	38.5	98.6	157.6	203.2	231.6
RADIUS = .500								
AMPLITUDE =	.3650	.0182	.0116	.0167	.0256	.0279	.0242	.0154
PHASE ANGLE =	264.2	92.7	78.0	78.9	113.3	145.8	175.6	206.2
RADIUS = .600								
AMPLITUDE =	.3289	.0341	.0228	.0031	.0103	.0163	.0162	.0097
PHASE ANGLE =	266.0	98.0	142.4	163.1	76.8	110.1	136.2	157.0
RADIUS = .700								
AMPLITUDE =	.3059	.0474	.0386	.0155	.0103	.0146	.0160	.0115
PHASE ANGLE =	267.4	97.9	153.8	228.9	351.9	61.5	95.9	109.9
RADIUS = .800								
AMPLITUDE =	.3051	.0555	.0471	.0261	.0117	.0129	.0137	.0112
PHASE ANGLE =	267.1	91.2	152.4	223.0	315.8	37.4	75.5	86.3
RADIUS = .900								
AMPLITUDE =	.3020	.0619	.0555	.0362	.0173	.0134	.0131	.0108
PHASE ANGLE =	267.0	86.5	148.4	216.1	287.3	7.7	57.8	74.4
RADIUS = 1.000								
AMPLITUDE =	.2944	.0664	.0647	.0462	.0271	.0174	.0135	.0092
PHASE ANGLE =	267.3	83.5	143.0	208.9	272.6	342.4	47.0	74.7

TABLE B-24 CONTINUED

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	9	10	11	12	13	14	15
RADIUS = .280							
AMPLITUDE =	.0242	.0296	.0276	.0157	.0085	.0066	.0043
PHASE ANGLE =	129.1	186.9	236.3	274.5	295.0	296.6	6.7
RADIUS = .300							
AMPLITUDE =	.0203	.0250	.0221	.0114	.0057	.0050	.0034
PHASE ANGLE =	131.7	185.5	236.0	270.6	288.6	288.1	15.5
RADIUS = .400							
AMPLITUDE =	.0067	.0076	.0040	.0057	.0052	.0029	.0027
PHASE ANGLE =	165.2	162.0	161.9	127.0	141.1	178.1	84.7
RADIUS = .500							
AMPLITUDE =	.0048	.0057	.0112	.0125	.0087	.0043	.0040
PHASE ANGLE =	242.1	62.7	83.8	108.3	123.9	134.8	88.6
RADIUS = .600							
AMPLITUDE =	.0037	.0046	.0047	.0043	.0055	.0069	.0082
PHASE ANGLE =	135.5	96.8	83.0	66.5	36.3	36.2	45.6
RADIUS = .700							
AMPLITUDE =	.0079	.0051	.0005	.0053	.0099	.0112	.0106
PHASE ANGLE =	107.0	118.6	52.5	346.2	.8	18.6	31.2
RADIUS = .800							
AMPLITUDE =	.0082	.0061	.0026	.0036	.0069	.0080	.0078
PHASE ANGLE =	85.2	90.9	62.7	6.0	353.6	359.7	1.6
RADIUS = .900							
AMPLITUDE =	.0078	.0068	.0045	.0032	.0048	.0061	.0069
PHASE ANGLE =	72.4	71.9	57.4	28.7	347.0	338.3	333.2
RADIUS = 1.000							
AMPLITUDE =	.0061	.0065	.0057	.0037	.0041	.0049	.0060
PHASE ANGLE =	66.8	54.0	47.0	26.1	346.8	326.8	317.8

APPENDIX C

VELOCITY COMPONENT RATIOS AND HARMONIC ANALYSIS FOR YAWED MODEL STRAIGHT WAKE SURVEYS - EXPERIMENTS 184 AND 185

TABLE C-1

INPUT DATA FOR HARMONIC ANALYSIS FOR FF 1088, MODEL 4989 EXPERIMENT 184

INPUT DATA

RADIUS = .330

ANGLE	VX V	VT/V	VR/V
0.0	.802	-.042	.082
1.3	.806	-.047	.079
3.3	.811	-.059	.074
8.5	.821	-.085	.043
10.4	.827	-.100	.027
13.9	.844	-.130	.027
17.0	.860	-.156	.024
21.1	.893	-.173	.019
24.5	.931	-.186	.013
28.1	.970	-.194	.014
31.6	1.006	-.183	.011
35.1	1.024	-.181	.007
44.1	1.000	-.164	-.015
52.9	.995	-.156	-.016
61.9	.981	-.144	-.008
70.8	.982	-.124	-.001
79.8	.989	-.094	.008
106.9	.984	.028	.030
115.9	.986	.077	.031
124.7	.999	.109	.029
133.8	1.006	.173	.027
142.7	1.026	.207	.024
151.0	1.046	.236	.019
160.9	1.069	.269	.016
169.9	1.078	.301	.011
179.0	1.085	.324	.005
197.5	1.096	.332	-.004
215.3	1.088	.322	-.010
224.2	1.102	.306	-.011
233.3	1.109	.279	-.026
242.3	1.124	.249	.004
251.2	1.123	.210	.048
260.0	1.047	.165	.074
269.4	.916	.133	.012
278.0	.837	.045	.056
287.9	.847	.043	.076
[illegible]	.852	.063	.077
294.7	.849	.073	.071
300.3	.846	.082	.062
305.0	.841	.080	.063
316.0	.835	.033	.103
327.0	.857	.023	.120
332.9	.849	.047	.095
338.3	.846	.025	.045
343.7	.835	-.021	.056
346.9	.863	-.024	.074
350.0	.892	-.008	.079
354.3	.893	-.002	.080
357.8	.828	-.012	.084
359.0	.801	-.039	.084
360.0	.802	-.042	.082

RADIUS = .512

ANGLE	VX V	VT/V	VR/V
0.0	1.040	.014	-.069
2.3	1.032	.014	-.047
4.1	1.024	.011	-.027
13.0	.932	-.011	.012
15.2	.892	-.026	.018
20.5	.910	-.068	.022
25.8	.956	-.130	-.009
38.5	1.006	-.096	.006
47.5	1.005	-.092	.038
56.3	1.018	-.088	.077
74.2	1.015	-.060	.136
92.0	1.016	-.012	.173
101.0	1.016	.012	.184
110.0	1.000	.049	.192
119.0	.989	.075	.191
137.9	.990	.138	.181
146.9	.990	.167	.171
161.0	1.018	.216	.135
179.3	1.043	.238	.092
190.1	1.050	.251	.045
200.0	1.056	.262	.010
218.4	1.043	.257	-.029
235.0	1.035	.224	-.087
254.1	1.031	.167	-.135
264.9	1.022	.141	-.134
271.9	.954	.121	-.113
282.7	.926	.044	-.056
300.0	.942	-.019	.010
307.8	.959	-.008	.024
318.0	.976	.015	.023
325.5	.967	.037	.028
332.0	.919	.105	.053
336.5	.853	.079	.026
341.0	1.006	-.052	-.032
343.9	1.042	-.022	-.070
354.9	1.045	.014	-.065
360.0	1.040	.014	-.069

RADIUS = .711

ANGLE	VX V	VT/V	VR/V
0.0	.939	-.038	-.093
4.0	.925	-.040	-.083
8.0	.901	-.043	-.068
8.8	.885	-.042	-.063
12.1	.866	-.037	-.043
17.6	.817	-.071	.005
19.3	.801	-.078	.014
22.8	.782	-.107	.025
26.4	.803	-.166	.003
35.2	.845	-.149	.018
44.1	.880	-.154	.064
52.0	.869	-.148	.113
61.9	.915	-.133	.151
70.9	.932	-.119	.179
79.8	.941	-.095	.203
88.8	.946	-.064	.224
97.0	.937	-.028	.235
106.9	.941	.006	.248
115.9	.935	.037	.250
124.8	.928	.067	.247
133.6	.914	.100	.240
142.6	.917	.126	.229
151.7	.923	.152	.212
160.8	.928	.177	.192
169.0	.926	.198	.164
179.1	.936	.208	.139
188.0	.941	.220	.109
197.5	.953	.224	.075
206.5	.960	.234	.035
215.0	.966	.227	-.001
224.2	.958	.218	-.034
233.3	.943	.211	-.079
242.3	.946	.188	-.113
251.3	.945	.163	-.137
260.3	.955	.129	-.157
269.4	.939	.120	-.167
278.0	.801	.067	-.130
287.5	.829	.033	-.005

TABLE C-1 CONTINUED

[illegible]	.857	[illegible]	.076
305.8	.842	[illegible]	[illegible]
314.9	.910	.054	.069
[illegible]	.849	.053	.088
[illegible]	.896	.051	.090
[illegible]	.901	.054	.095
331.2	[illegible]	.043	.067
333.0	[illegible]	.107	.036
[illegible]	[illegible]	-.019	-.092
[illegible]	.928	-.029	-.103
[illegible]	[illegible]	-.029	-.100
[illegible]	[illegible]	[illegible]	[illegible]

RADIUS = [illegible]

ANGLE	VX/V	VT/V	VR/V
0.0	[illegible]	-.023	-.110
3.0	[illegible]	-.025	-.108
6.8	.958	-.020	-.100
10.5	.936	-.026	-.069
17.5	.879	-.026	-.042
19.8	.861	-.028	-.024
24.0	.811	-.066	[illegible]
26.0	[illegible]	-.143	-.057
[illegible]	[illegible]	-.130	-.046
[illegible]	.865	-.135	-.015
36.0	.876	-.138	[illegible]
[illegible]	.871	-.131	.075
[illegible]	[illegible]	-.122	.117
[illegible]	.910	-.105	.152
[illegible]	[illegible]	-.089	.176
[illegible]	[illegible]	-.066	[illegible]
[illegible]	[illegible]	-.040	[illegible]
102.1	.946	-.013	[illegible]
110.0	.952	.018	.241
120.0	.941	.055	[illegible]
130.0	.933	.087	[illegible]
138.0	[illegible]	.117	[illegible]
147.6	.935	.143	.216
[illegible]	.929	.185	.172
[illegible]	.931	.219	[illegible]
190.0	[illegible]	[illegible]	[illegible]
199.5	.957	.234	.053
208.0	.972	.241	.016
216.0	.984	.240	-.017
225.9	.977	.232	-.052
[illegible]	.964	.220	[illegible]
[illegible]	.971	.204	[illegible]
[illegible]	.971	.180	[illegible]
[illegible]	.963	.167	-.192
[illegible]	.960	.120	[illegible]
279.8	.903	.064	-.097
[illegible]	.841	.077	-.003
[illegible]	.954	.090	.041
[illegible]	.961	.100	[illegible]
[illegible]	.970	.089	[illegible]
[illegible]	.968	.085	.027
[illegible]	.953	.074	[illegible]
[illegible]	.954	.081	.019
333.5	.965	.131	[illegible]
337.1	.889	-.033	-.047
340.0	.910	.023	-.111
344.0	.925	.021	-.104
346.1	.928	.007	-.112
[illegible]	.935	-.016	-.114
359.2	.936	-.021	-.110
360.0	.938	-.023	-.110

RADIUS = 1.082

ANGLE	VX/V	VT/V	VR/V
0.0	.835	-.028	[illegible]
3.4	.836	-.041	[illegible]
7.0	.858	-.047	-.110
10.5	.887	-.049	[illegible]
14.0	.903	-.058	[illegible]
17.6	.911	-.057	-.064
21.1	.848	-.054	[illegible]
24.5	.846	-.027	[illegible]
27.0	.834	-.137	[illegible]
31.7	.807	-.159	-.091
35.2	.807	-.166	.015
38.7	.827	-.136	[illegible]
45.9	.845	-.143	.103
53.0	.869	-.155	[illegible]
60.7	.897	-.149	[illegible]
70.8	.908	-.132	[illegible]
81.5	.916	-.108	[illegible]
92.3	.924	[illegible]	[illegible]
97.0	.927	-.057	[illegible]
105.8	.932	-.018	[illegible]
116.9	.938	.008	[illegible]
124.3	.933	.029	[illegible]
131.4	.932	.051	[illegible]
138.2	.932	.059	[illegible]
138.4	.937	.068	[illegible]
145.5	.935	.089	[illegible]
152.7	.927	.106	[illegible]
167.3	.938	.145	[illegible]
174.6	.949	.160	.170
181.6	.949	.173	[illegible]
[illegible]	.957	.168	[illegible]
[illegible]	.973	.138	[illegible]
[illegible]	.978	[illegible]	.020
226.2	.984	.183	[illegible]
233.3	.983	.175	[illegible]
240.6	.982	.166	[illegible]
252.8	.963	.151	[illegible]
259.0	.939	.144	[illegible]
262.3	.913	.137	[illegible]
[illegible]	.886	.097	[illegible]
271.0	.884	.063	[illegible]
276.6	.906	.013	[illegible]
283.9	.937	.010	-.023
[illegible]	.939	.040	.034
[illegible]	.947	.062	[illegible]
[illegible]	.943	.071	[illegible]
[illegible]	.944	.076	[illegible]
316.0	.939	.063	[illegible]
322.4	.942	.063	[illegible]
327.6	.947	.057	[illegible]
[illegible]	.936	-.031	[illegible]
[illegible]	.919	.032	-.101
352.8	.886	.008	[illegible]
357.0	.854	-.015	[illegible]
360.0	.835	-.028	-.110

TABLE C-2 - LISTING OF THE MEAN VELOCITY COMPONENT RATIOS, THE MEAN ADVANCE ANGLES AND OTHER DERIVED QUANTITIES AT THE EXPERIMENTAL AND INTERPOLATED RADII FOR EXPERIMENT 184

RADIUS =	.330	.512	.711	.910	1.062	.269	.300	.400	.500	.600	.700	.800	.900	1.000
VXBAR =	.978	1.001	.914	.934	.924	.959	.965	.948	1.002	.949	.916	.927	.933	.932
VTBAR =	.084	.076	.055	.072	.038	.084	.084	.082	.077	.062	.055	.070	.072	.059
VRBAR =	.029	.038	.064	.045	.063	.029	.029	.031	.037	.055	.064	.050	.045	.051
1-WVX =	.969	.992	.974	.950	.944	0.000	.962	.982	.943	.987	.969	.955	.950	.946
1-WX =	.916	.947	.940	.924	.921	0.000	.908	.932	.948	.948	.936	.927	.923	.922
BBAR =	35.45	25.72	17.88	14.43	12.23	38.33	37.52	31.24	26.26	21.52	18.17	16.17	14.58	13.22
BPCS =	7.53	2.30	2.45	.72	.48	9.85	9.15	4.81	2.42	2.47	2.50	1.39	.75	.43
THETA =	35.00	57.50	357.50	7.50	225.00	37.50	37.50	35.00	35.00	357.50	357.50	357.50	7.50	332.50
BNEG =	-3.88	-3.40	-1.89	-1.25	-1.12	-5.90	-5.30	-3.51	-3.45	-2.85	-1.99	-1.50	-1.26	-1.11
THETA =	305.00	335.00	335.00	25.00	27.50	305.00	305.00	335.00	335.00	335.00	335.00	22.50	25.00	25.00

VXBAR IS CIRCUMFERENTIAL MEAN LONGITUDINAL VELOCITY.
VTBAR IS CIRCUMFERENTIAL MEAN TANGENTIAL VELOCITY.
VRBAR IS CIRCUMFERENTIAL MEAN RADIAL VELOCITY.
1-WVX IS VOLUMETRIC MEAN WAKE VELOCITY WITHOUT TANGENTIAL CORRECTION.
1-WX IS VOLUMETRIC MEAN WAKE VELOCITY WITH TANGENTIAL CORRECTION.
BBAR IS MEAN ANGLE OF ADVANCE.
BPOS IS VARIATION BETWEEN THE MAXIMUM AND MEAN ADVANCE ANGLES (DELTA BETA PLUS).
BNEG IS VARIATION BETWEEN THE MINIMUM AND MEAN ADVANCE ANGLES (DELTA BETA MINUS).
THETA IS ANGLE IN DEGREES AT WHICH CORRESPONDING BPOS OR BNEG OCCURS.

TABLE C-3 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 184

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	1	2	3	4	5	6	7	8	9	10
RADIUS = .330										
AMPLITUDE =	.1136	.0633	.0061	.0295	.0269	.0006	.0168	.0145	.0013	.0068
PHASE ANGLE =	278.9	3	[illegible]	215.8	275.9	205.8	167.2	201.2	149.2	93.5
RADIUS = .512										
AMPLITUDE =	.0297	.0269	.0178	.0166	.0070	.0113	.0193	.0176	.0101	.0089
PHASE ANGLE =	282.8	17.3	160.0	149.4	189.6	96.2	113.4	133.0	144.2	134.5
RADIUS = .711										
AMPLITUDE =	.0349	.0078	.0284	.0200	.0078	.0094	.0201	.0163	.0085	.0031
PHASE ANGLE =	270.6	320.5	151.6	149.0	150.6	60.9	81.5	120.1	133.5	63.9
RADIUS = .910										
AMPLITUDE =	.0302	.0104	.0248	.0061	.0036	.0099	.0153	.0072	.0021	.0067
PHASE ANGLE =	223.8	215.0	143.8	185.0	46.7	28.7	63.5	96.8	64.4	22.3
RADIUS = 1.082										
AMPLITUDE =	.0457	.0116	.0267	.0092	.0075	.0064	.0053	.0108	.0109	.0029
PHASE ANGLE =	236.1	213.7	170.7	234.4	21.3	57.0	294.8	297.1	312.8	286.0

TABLE C-4 – HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 184

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	1	2	3	4	5	6	7	8	9	10
RADIUS = .289										
AMPLITUDE =	.1442	.0772	.0101	.0387	.0359	.0048	.0268	.0178	.0021	.0070
PHASE ANGLE =	278.2	357.1	34.7	223.3	280.0	274.4	181.8	220.3	325.2	68.5
RADIUS = .300										
AMPLITUDE =	.1356	.0736	.0088	.0361	.0314	.0035	.0202	.0167	.0011	.0069
PHASE ANGLE =	278.4	357.9	45.1	221.6	279.1	271.5	178.0	215.7	323.6	75.5
RADIUS = .400										
AMPLITUDE =	.0713	.0479	.0082	.0196	.0147	.0060	.0180	.0136	.0059	.0031
PHASE ANGLE =	280.3	6.6	141.3	194.1	262.0	104.5	142.4	164.5	146.4	120.5
RADIUS = .500										
AMPLITUDE =	.0326	.0288	.0168	.0164	.0069	.0110	.0196	.0172	.0099	.0090
PHASE ANGLE =	262.7	16.2	159.6	152.9	198.8	97.1	115.8	135.0	144.5	133.9
RADIUS = .600										
AMPLITUDE =	.0346	.0164	.0242	.0204	.0082	.0101	.0200	.0180	.0100	.0050
PHASE ANGLE =	279.7	2.8	154.5	147.9	167.2	81.2	96.3	126.7	139.3	120.4
RADIUS = .700										
AMPLITUDE =	.0351	.0083	.0282	.0203	.0080	.0094	.0201	.0166	.0087	.0030
PHASE ANGLE =	271.9	326.8	151.8	148.7	152.1	62.9	82.7	120.8	134.2	70.7
RADIUS = .800										
AMPLITUDE =	.0270	.0059	.0263	.0120	.0038	.0099	.0200	.0136	.0063	.0060
PHASE ANGLE =	243.8	247.5	147.4	154.9	124.2	38.2	72.8	110.9	122.8	34.6
RADIUS = .900										
AMPLITUDE =	.0296	.0101	.0243	.0064	.0034	.0100	.0160	.0079	.0025	.0068
PHASE ANGLE =	224.5	216.1	149.2	160.5	51.5	28.9	64.5	98.8	93.6	23.4
RADIUS = 1.000										
AMPLITUDE =	.0368	.0122	.0248	.0065	.0058	.0084	.0077	.0023	.0044	.0045
PHASE ANGLE =	226.0	210.9	158.8	223.5	25.9	33.8	46.0	350.4	327.0	4.5

TABLE C-5 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS
AT THE EXPERIMENTAL RADII FOR EXPERIMENT 184

HARMONIC ANALYSIS OF TANGENTIAL VELOCITY COMPONENT RATIOS [illegible]

HARMONIC =	[illegible]	2	3	4	5	6	7	8	9	10
RADIUS = .330										
AMPLITUDE =	[illegible]	.0570	[illegible]	.0122	[illegible]	.0095	.0093	.0052	.0036	.0056
PHASE ANGLE =	[illegible]	115.[illegible]	[illegible]	[illegible]	124.5	87.8	117.4	134.5	290.2	8.8
RADIUS = .512										
AMPLITUDE =	[illegible]	.0430	.0184	.0167	.0069	.0048	.0119	.0108	.0083	.0072
PHASE ANGLE =	[illegible]	57.3	121.2	152.6	182.1	310.5	13.0	28.4	30.0	3.1
RADIUS = .711										
AMPLITUDE =	[illegible]	.0410	.0254	.0095	.0046	.0058	.0087	.0073	.0066	.0066
PHASE ANGLE =	[illegible]	121.2	[illegible]	182.4	284.5	340.2	6.1	2.6	342.5	330.1
RADIUS = .910										
AMPLITUDE =	.1623	.0384	[illegible]	.0057	.0085	.0113	.0071	.0021	.0059	.0056
PHASE ANGLE =	231.1	119.2	140.8	212.5	339.7	13.2	20.6	320.6	303.3	320.7
RADIUS = 1.082										
AMPLITUDE =	.1470	.0394	.0213	.0039	.0104	.0129	.0096	.0060	.0067	.0038
PHASE ANGLE =	227.7	114.7	130.[illegible]	[illegible]	323.7	29.7	81.0	171.9	260.3	311.8

TABLE C-6 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 184

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT/V)

HARMONIC =	1	2	3	4	5	6	7	8	9	10
RADIUS = .289										
AMPLITUDE =	.2522	.0606	.0277	.0128	.0026	.0144	.0143	.0090	.0069	.0048
PHASE ANGLE =	241.3	124.3	167.4	217.8	29.4	91.2	135.9	162.9	[illegible]1.6	3.4
RADIUS = .300										
AMPLITUDE =	.2452	.0583	.0271	.0124	.0019	.0130	.0128	.0078	.0058	.0050
PHASE ANGLE =	241.6	122.0	163.7	211.4	43.2	90.6	132.2	157.6	266.4	5.3
RADIUS = .400										
AMPLITUDE =	.1935	.0452	.0264	.0142	.0048	.0032	.0069	.0058	.0044	.0066
PHASE ANGLE =	243.7	100.7	135.1	167.3	168.7	62.5	55.1	57.7	13.3	12.0
RADIUS = .500										
AMPLITUDE =	.1625	.0404	.0283	.0166	.0069	.0043	.0115	.0104	.0081	.0072
PHASE ANGLE =	244.0	88.3	121.8	153.2	180.7	312.6	14.8	29.9	30.1	9.0
RADIUS = .600										
AMPLITUDE =	.1638	.0392	.0273	.0128	.0042	.0050	.0103	.0093	.0071	.0067
PHASE ANGLE =	239.3	107.4	129.7	164.4	222.6	319.2	8.4	16.3	8.4	348.0
RADIUS = .700										
AMPLITUDE =	.1662	.0408	.0257	.0097	.0045	.0057	.0088	.0075	.0066	.0066
PHASE ANGLE =	235.5	120.4	136.6	180.5	281.7	337.9	6.1	3.9	344.9	331.4
RADIUS = .800										
AMPLITUDE =	.1663	.0394	.0216	.0073	.0059	.0087	.0083	.0053	.0062	.0063
PHASE ANGLE =	233.3	120.8	140.5	196.7	328.9	.6	5.3	349.4	326.6	325.6
RADIUS = .900										
AMPLITUDE =	.1628	.0384	.0195	.0058	.0083	.0111	.0073	.0024	.0059	.0057
PHASE ANGLE =	231.3	119.4	141.0	211.4	339.7	12.3	18.2	325.7	305.6	321.1
RADIUS = 1.000										
AMPLITUDE =	.1557	.0385	.0195	.0047	.0097	.0125	.0070	.0021	.0060	.0048
PHASE ANGLE =	229.4	117.1	136.8	217.6	335.0	21.5	51.6	196.9	280.9	316.5

TABLE C-7

INPUT DATA FOR HARMONIC ANALYSIS FOR FF 1088, MODEL 4989, EXPERIMENT 185

INPUT DATA

RADIUS = .330

ANGLE	VX/V	VT/V	VR/V
0.0	.709	-.100	.075
3.9	.704	-.118	.060
6.2	.712	-.143	.057
11.5	.763	-.164	.040
16.8	.809	-.196	.025
22.1	.870	-.220	.026
27.5	.969	-.219	.018
32.7	1.007	-.199	.009
37.0	1.005	-.137	-.002
43.4	.997	-.174	-.008
48.8	.997	-.173	-.007
54.1	.993	-.163	-.012
68.4	.981	-.130	.004
77.0	.972	-.090	.014
86.2	.957	-.051	.025
104.2	.972	.042	.035
113.0	.977	.092	.036
121.0	.984	.141	.033
131.1	.998	.181	.028
139.0	1.016	.212	.029
146.0	1.037	.250	.026
160.0	1.062	.315	.018
175.9	1.073	.334	.011
185.1	1.077	.350	.005
203.5	1.075	.358	-.005
212.6	1.084	.346	-.010
221.7	1.084	.322	-.010
230.7	1.104	.268	.005
239.9	1.107	.247	.042
245.2	1.098	.233	.051
250.7	1.088	.206	.087
257.9	.890	.180	.061
261.5	.871	.141	.064
266.7	.854	.075	.050
277.0	.870	-.005	.048
282.0	.884	.014	.042
288.6	.867	.034	.046
293.9	.848	.049	.046
299.3	[illegible]	.053	.043
304.7	.855	.069	.039
310.0	.849	.090	.037
315.6	.830	.083	.074
320.9	.721	.072	.095
326.0	.732	.037	.097
331.7	.694	.020	.087
337.2	.688	-.015	.057
347.9	.743	-.030	.091
353.2	.753	-.036	.050
358.6	.711	-.087	.078
360.0	.709	-.100	.075

RADIUS = .512

ANGLE	VX/V	VT/V	VR/V
0.0	.907	-.014	-.050
4.6	.854	-.052	.027
10.9	.821	-.088	.116
18.4	.767	-.126	.061
25.8	.899	-.145	.031
36.0	.939	-.117	[illegible]
47.4	.970	-.107	.066
58.0	.977	-.093	.107
79.0	.997	-.051	.160
90.7	.999	-.015	.175
108.0	.976	.048	.193
127.0	.964	.113	.192
144.0	.975	.183	.169
163.0	1.010	.224	[illegible]
180.0	1.021	.258	.069
188.0	1.038	.263	[illegible]
198.6	1.049	.271	[illegible]
216.3	1.040	.265	-.028
234.2	1.017	.235	-.084
252.2	1.002	.185	-.141
287.0	.931	-.007	.001
296.1	.934	-.033	.040
305.9	.932	-.011	.057
314.5	.929	.001	.047
323.7	.917	.026	.036
332.5	.848	.091	.030
337.0	.777	.003	-.012
341.7	.888	-.057	-.041
350.6	.924	-.004	-.101
355.0	.921	-.010	-.080
360.0	.907	-.014	-.050

RADIUS = .711

ANGLE	VX/V	VT/V	VR/V
0.0	.873	-.057	-.115
5.0	.866	-.076	-.103
15.0	.852	-.087	.015
18.0	.791	-.122	.149
23.9	.727	-.182	.104
32.8	.798	-.159	.054
36.0	.830	-.153	.066
41.0	.862	[illegible]	.091
71.0	.907	[illegible]	.191
89.0	.925	-.046	.229
107.0	.923	.026	.246
126.1	.921	.086	.241
143.8	.904	.145	.224
161.7	.923	.186	.185
179.9	.928	.218	.131
198.3	.951	.238	.060
216.6	.948	.236	-.020
252.8	.950	.167	-.163
261.9	.933	.144	-.185
270.8	.917	.114	-.160
279.9	.821	.054	-.116
290.8	.828	.005	.016
294.0	.830	-.001	.058
301.6	.865	-.004	.096
312.0	.886	.041	.078
324.0	.871	.039	.082
330.4	.822	.081	.097
334.0	.784	.083	.023
339.4	.853	-.028	-.092
348.4	.853	-.016	-.111
357.0	.875	-.036	-.114
360.0	.873	-.057	-.115

TABLE C-7 CONTINUED

RADIUS = .910

ANGLE	VX/V	VT/V	VR/V
0.0	.900	-.011	-.117
1.6	.894	-.012	-.112
7.0	.862	-.008	-.103
12.6	.843	-.015	-.072
23.7	.816	-.030	.066
29.1	.841	-.121	.012
34.0	.851	-.116	.012
39.0	.859	-.106	.061
51.0	.898	-.125	.104
59.8	.902	-.112	.134
70.7	.911	-.095	.167
90.5	.925	-.040	.220
99.0	.936	-.014	.231
110.4	.933	.024	.237
119.5	.924	.059	.248
130.0	.916	.099	.258
139.0	.916	.133	.224
150.1	.927	.167	.207
160.9	.934	.193	.180
169.8	.934	.214	.152
180.0	.930	.238	.108
198.7	.936	.253	.041
216.0	.956	.250	-.025
234.2	.947	.231	-.105
252.0	.956	.188	-.169
270.0	.950	.146	-.212
275.0	.912	.120	-.177
280.7	.864	.086	-.103
291.7	.853	.069	.010
302.2	.921	.089	.042
307.7	.940	.097	.027
313.4	.949	.085	.025
323.0	.941	.072	.024
328.0	.936	.076	.022
334.4	.844	.129	-.010
339.8	.911	.014	-.112
350.0	.922	.009	-.124
355.0	.915	-.002	-.122
360.0	.900	-.011	-.117

RADIUS = 1.082

ANGLE	VX/V	VT/V	VR/V
0.0	.843	-.013	-.119
2.4	.843	-.021	-.110
7.8	.886	-.028	-.093
14.9	.877	-.045	-.049
21.0	.875	-.066	.002
29.2	.873	-.136	.014
36.3	.846	-.112	.044
43.4	.878	-.148	.084
61.3	.894	-.149	.170
79.2	.918	-.110	.236
97.1	.934	-.051	.272
115.1	.928	.019	.284
132.0	.914	.073	.267
150.8	.906	.131	.240
169.0	.935	.165	.194
187.1	.941	.194	.117
205.7	.957	.200	.042
223.6	.975	.195	-.036
241.7	.961	.171	-.118
259.8	.938	.137	-.192
265.3	.934	.110	-.169
276.1	.868	.069	-.132
281.5	.893	.040	-.027
287.1	.905	.047	.019
292.4	.904	.071	.040
297.9	.914	.077	.047
303.3	.932	.073	.052
308.7	.923	.070	.040
314.0	.919	.069	.025
319.0	.910	.065	.016
324.8	.889	.054	.011
330.0	.821	.050	.015
335.7	.802	-.014	-.031
341.0	.824	.019	-.117
346.0	.839	.022	-.108
351.8	.843	.004	-.115
357.1	.844	-.004	-.122
360.0	.843	-.013	-.119

TABLE C-8 - LISTING OF THE MEAN VELOCITY COMPONENT RATIOS, THE MEAN ADVANCE ANGLES AND OTHER DERIVED QUANTITIES AT THE EXPERIMENTAL AND INTERPOLATED RADII FOR EXPERIMENT 185

RADIUS =	.330	.512	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.700	.800	.900	1.000
VXBAR =	.947	.903	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.848	.908	.915	.915
VTBAR =	.083	.070	.055	.062	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.068	.054	.076	.082	.071
VRBAR =	.032	.051	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.052	.046	.050	.044	.051
1-WVX =	.940	.957	.943	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.939	.919	.925	.923
1-WX =	.889	.915	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.902	.916	.917	.908	.901	.899	.898
BBAR =	34.59	24.94	17.56	14.13	[illegible]	37.51	36.[illegible]	30.[illegible]	25.47	21.02	17.[illegible]	15.84	14.27	12.96
BPOS =	6.13	2.22	1.35	.68	[illegible]	10.[illegible]	10.[illegible]	4.7[illegible]	2.3[illegible]	1.52	1.40	.91	.69	.62
THETA =	32.50	70.00	57.50	97.50	[illegible]	32.50	32.50	32.50	82.50	60.00	57.50	57.50	97.50	97.50
BNEG =	-6.67	-3.66	-2.06	-1.14	-1.27	-8.15	-7.70	-5.23	-3.80	-2.87	-2.13	-1.64	-1.19	-1.11
THETA =	332.50	335.00	335.00	20.00	332.50	330.00	332.50	335.00	335.00	335.00	335.00	22.50	22.50	335.00

VXBAR IS CIRCUMFERENTIAL MEAN LONGITUDINAL VELOCITY.
VTBAR IS CIRCUMFERENTIAL MEAN TANGENTIAL VELOCITY.
VRBAR IS CIRCUMFERENTIAL MEAN RADIAL VELOCITY.
1-WVX IS VOLUMETRIC MEAN WAKE VELOCITY WITHOUT TANGENTIAL CORRECTION.
1-WX IS VOLUMETRIC MEAN WAKE VELOCITY WITH TANGENTIAL CORRECTION.
BBAR IS MEAN ANGLE OF ADVANCE.
BPOS IS VARIATION BETWEEN THE MAXIMUM AND MEAN ADVANCE ANGLES (DELTA BETA PLUS).
BNEG IS VARIATION BETWEEN THE MINIMUM AND MEAN ADVANCE ANGLES (DELTA BETA MINUS).
THETA IS ANGLE IN DEGREES AT WHICH CORRESPONDING BPOS OR BNEG OCCURS.

TABLE C-9 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 185

HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS (VX/V)

HARMONIC =	1	2	3	4	5	6	7	8	9	10
RADIUS = .330										
AMPLITUDE =	.1442	.0752	.0260	.0387	.0249	.0118	.0196	.0070	.0115	.0172
PHASE ANGLE =	283.6	345.9	297.9	271.6	323.9	125.4	190.2	225.9	130.1	155.4
RADIUS = .512										
AMPLITUDE =	.0686	.0297	.0246	.0030	.0049	.0079	.0166	.0148	.0138	.0106
PHASE ANGLE =	271.7	321.9	228.3	201.9	183.4	144.3	129.6	137.6	129.9	136.7
RADIUS = .711										
AMPLITUDE =	.0524	.0186	.0217	.0167	.0039	.0154	.0213	.0137	.0057	.0056
PHASE ANGLE =	270.1	310.7	159.9	172.3	186.6	63.5	78.5	94.2	77.7	322.8
RADIUS = .910										
AMPLITUDE =	.0327	.0105	.0199	.0174	.0077	.0044	.0177	.0133	.0078	.0028
PHASE ANGLE =	247.5	248.8	163.6	182.5	247.5	29.0	75.1	126.1	175.4	210.9
RADIUS = 1.082										
AMPLITUDE =	.0435	.0208	.0096	.0093	.0154	.0112	.0085	.0040	.0017	.0016
PHASE ANGLE =	258.7	307.9	159.2	327.1	351.4	47.6	58.7	119.2	284.1	237.0

TABLE C-10 - HARMONIC ANALYSES OF LONGITUDINAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 185

[illegible]

HARMONIC =	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	6	7	8	9	10
RADIUS = .250										
AMPLITUDE =	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.0222	.0101	.0005	.0185
PHASE ANGLE =	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	262.0	261.5	126.9	173.8
RADIUS = .300										
AMPLITUDE =	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	.0131	.0214	.0089	.0101	.0181
PHASE ANGLE =	[illegible]	[illegible]	[illegible]	[illegible]	[illegible]	116.6	149.0	254.0	126.0	171.5
RADIUS = .400										
AMPLITUDE =	[illegible]	[illegible]	[illegible]	.0214	.0105	.0101	.0168	.0092	.0137	.0151
PHASE ANGLE =	[illegible]	[illegible]	[illegible]	262.4	315.2	142.3	167.0	106.9	131.9	152.8
RADIUS = .500										
AMPLITUDE =	.0717	.0314	[illegible]	.0091	.0041	.0082	.0165	.0144	.0140	.0112
PHASE ANGLE =	272.6	324.1	[illegible]	211.6	191.4	146.2	133.3	139.6	130.4	138.3
RADIUS = .600										
AMPLITUDE =	.0622	.0252	.0141	.0129	.0044	.0114	.0180	.0132	.0086	.0010
PHASE ANGLE =	272.3	319.1	[illegible]	179.2	174.3	82.6	97.2	109.8	103.8	90.9
RADIUS = .700										
AMPLITUDE =	.0534	.0193	.0213	.0165	.0038	.0153	.0211	.0137	.0059	.0053
PHASE ANGLE =	270.5	311.9	[illegible]	172.5	183.9	54.6	79.6	94.7	78.8	323.9
RADIUS = .800										
AMPLITUDE =	.0384	.0106	.0224	.0209	.0079	.0076	.0207	.0143	.0061	.0022
PHASE ANGLE =	258.2	271.9	166.5	176.8	219.4	53.2	77.6	114.1	150.0	276.7
RADIUS = .900										
AMPLITUDE =	.0324	.0105	.0203	.0181	.0079	.0044	.0181	.0135	.0079	.0027
PHASE ANGLE =	247.9	248.1	153.2	181.7	243.6	30.5	75.5	125.4	174.0	213.2
RADIUS = 1.000										
AMPLITUDE =	.0332	.0121	.0152	.0077	.0074	.0061	.0135	.0097	.0054	.0027
PHASE ANGLE =	244.8	276.4	170.5	201.4	308.2	34.5	70.5	129.2	188.2	206.2

TABLE C-11 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE EXPERIMENTAL RADII FOR EXPERIMENT 185

HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS (VT,V)

HARMONIC =	1	2	3	4	5	6	7	8	9	10
RADIUS = .330										
AMPLITUDE =	.2441	.0578	.0399	.0218	.0086	.0106	.0134	.0086	.0022	.0050
PHASE ANGLE =	248.0	125.1	172.5	232.7	292.1	64.6	314.4	166.7	46.1	63.5
RADIUS = .512										
AMPLITUDE =	.1795	.0376	.0299	.0226	.0096	.0034	.0057	.0069	.0063	.0077
PHASE ANGLE =	248.9	94.4	138.0	188.1	229.3	325.0	51.3	47.3	49.8	65.7
RADIUS = .711										
AMPLITUDE =	.1750	.0333	.0292	.0161	.0093	.0059	.0086	.0074	.0039	.0043
PHASE ANGLE =	240.6	122.2	138.6	178.4	227.0	312.7	26.2	43.8	41.3	16.6
RADIUS = .910										
AMPLITUDE =	.1626	.0404	.0173	.0038	.0077	.0113	.0072	.0041	.0050	.0064
PHASE ANGLE =	231.7	111.6	129.6	196.6	314.4	342.8	357.5	4.4	299.1	320.3
RADIUS = 1.082										
AMPLITUDE =	.1515	.0427	.0200	.0011	.0078	.0083	.0056	.0028	.0013	.0024
PHASE ANGLE =	229.3	120.3	118.8	234.6	340.6	27.8	87.2	160.4	239.2	21.2

TABLE C-12 - HARMONIC ANALYSES OF TANGENTIAL VELOCITY COMPONENT RATIOS AT THE INTERPOLATED RADII FOR EXPERIMENT 185

HARMONIC ANALYSES OF TANGENTI[illegible] VELOCITY COMPONENT RATIOS [illegible]

HARMONIC =	1	2	[illegible]	4	5	6	7	8	9	10
RADIUS = .200										
AMPLITUDE =	[illegible]	.0078	[illegible]	.0298	.0115	.0144	.0170	.0130	.0005	.0035
PHASE ANGLE =	[illegible]	132.8	[illegible]	247.3	309.1	68.4	119.1	176.1	31.3	55.1
RADIUS = .300										
AMPLITUDE =	.2603	.0047	[illegible]	.0231	.0099	.0133	.0160	.0118	.0010	.0039
PHASE ANGLE =	247.4	130.6	[illegible]	243.4	305.0	67.5	118.0	174.2	42.0	58.3
RADIUS = .400										
AMPLITUDE =	.2126	.0405	[illegible]	.0213	.0078	.0054	.0065	.0040	.0045	.0068
PHASE ANGLE =	249.1	110.9	[illegible]	210.1	259.1	49.2	59.6	119.1	50.1	67.6
RADIUS = .500										
AMPLITUDE =	.1820	.0383	[illegible]	.0226	.0094	.0032	.0057	.0065	.0062	.0077
PHASE ANGLE =	249.0	95.4	[illegible]	189.8	231.0	332.5	56.6	49.9	49.9	66.2
RADIUS = .600										
AMPLITUDE =	.1784	.0332	[illegible]	.0204	.0106	.0043	.0076	.0077	.0056	.0057
PHASE ANGLE =	245.2	110.5	[illegible]	182.6	222.8	307.5	37.5	47.6	51.5	51.5
RADIUS = .700										
AMPLITUDE =	.1754	.0331	[illegible]	.0166	.0096	.0058	.0086	.0075	.0041	.0043
PHASE ANGLE =	241.1	121.7	[illegible]	178.6	225.9	311.4	27.3	44.5	43.4	22.6
RADIUS = .800										
AMPLITUDE =	[illegible]	.0368	[illegible]	[illegible]	.0065	.0098	.0085	.0061	.0037	.0056
PHASE ANGLE =	235.9	114.0	[illegible]	182.8	271.2	330.1	3.5	21.7	328.5	332.8
RADIUS = .900										
AMPLITUDE =	.1632	.0402	[illegible]	.0042	.0075	.0113	.0075	.0044	.0049	.0064
PHASE ANGLE =	232.0	111.5	[illegible]	134.6	311.9	341.6	357.0	5.5	[illegible]	320.5
RADIUS = 1.000										
AMPLITUDE =	.1571	.0420	[illegible]	.0017	.0065	.0101	.0047	.0013	.0039	.0047
PHASE ANGLE =	[illegible]	114.3	[illegible]	224.6	330.4	359.3	21.1	3.8	266.5	326.1

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